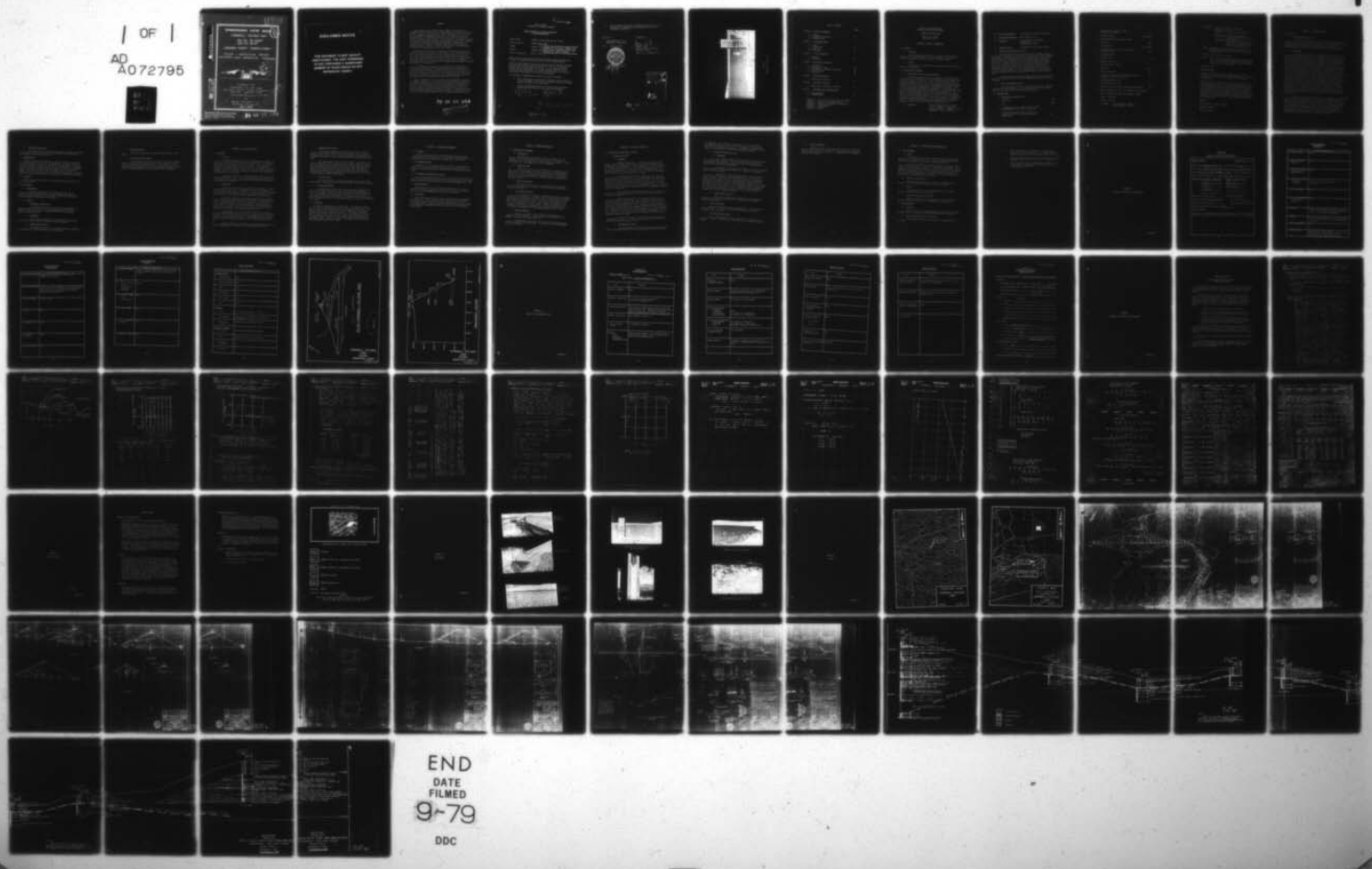
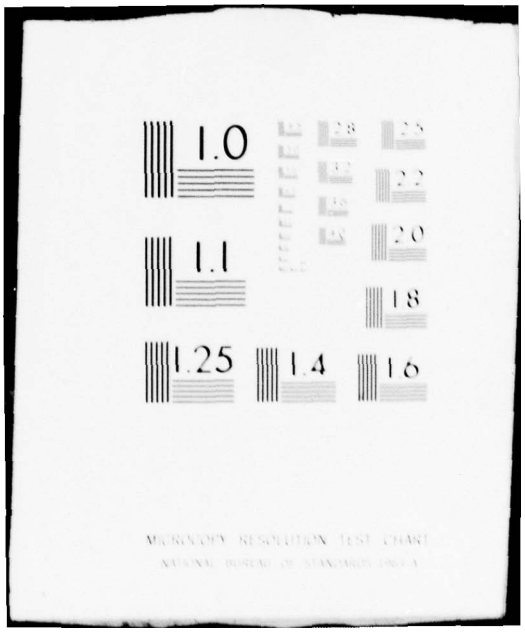
AD-A072 795 BERGER ASSOCIATES INC HARRISBURG PA F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. CORNWALL TAILINGS DAM (NDI NUM--ETC(U)
JUL 79 DACW31-79-C-0012
UNCLASSIFIED NL

| OF |
AD A072795



END
DATE FILMED
9-79
DDC


1.0
1.1
1.25
1.4
1.6
2.2
2.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

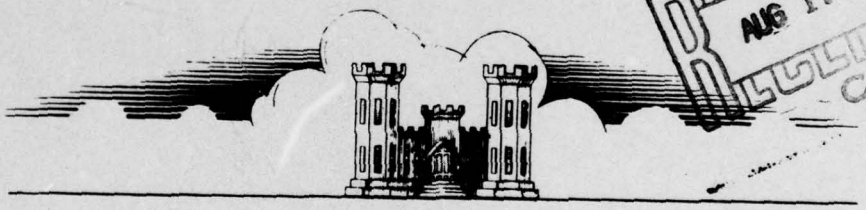
SUSQUEHANNA RIVER BASIN

CORNWALL TAILINGS DAM

NDI NO. PA-00597
DER NO. 38-87

LEBANON COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



PREPARED FOR
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203
Contract # DACW31-79-C-0012

BY

Berger Associates, Inc.
Harrisburg, Pennsylvania

JULY 1979

411 005

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DDC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

(15) DACW31-79-C-0012

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND RECOMMENDATIONS

Name of Dam:	CORNWALL TAILINGS DAM, NDI NO. PA-597
State & State No:	PENNSYLVANIA, 38-87
County:	LEBANON
Stream:	BERNHARD CEEK
Date of Inspection:	May 11, 1979

(6) National Dam Inspection Program. Cornwall Tailings Dam (NDI Number PA-00597, DER Number 38-87), Susquehanna River Basin, Bernhard Creek, Lebanon County, Pennsylvania. Phase I Inspection Report.

Based upon the visual inspection and the available engineering data, the dam and its appurtenant structures appear to be in good condition.

Hydrologic and hydraulic calculations indicate that the present reservoir has sufficient storage capacity to handle the inflow of the Probable Maximum Flood without overtopping the dam. It is considered that the storage capacity is adequate. It has been estimated that the yearly evaporation and leakage equals the annual inflow and that, as a result, an increase in the normal pool level is very unlikely.

The following recommendations are made for action by the owner:

1. That a staff gauge be installed on the decant tower located in the pool and that at least monthly readings be taken to establish records of changes in the pool level.

2. That the 6-inch blowoff valve on the decant pipe be located and made operable for use in the event of an emergency.

(12) 82 p (11) Jul 79

411 003

3. That a formal surveillance and downstream warning system be developed for implementation during periods of heavy or prolonged precipitation.

SUBMITTED BY:

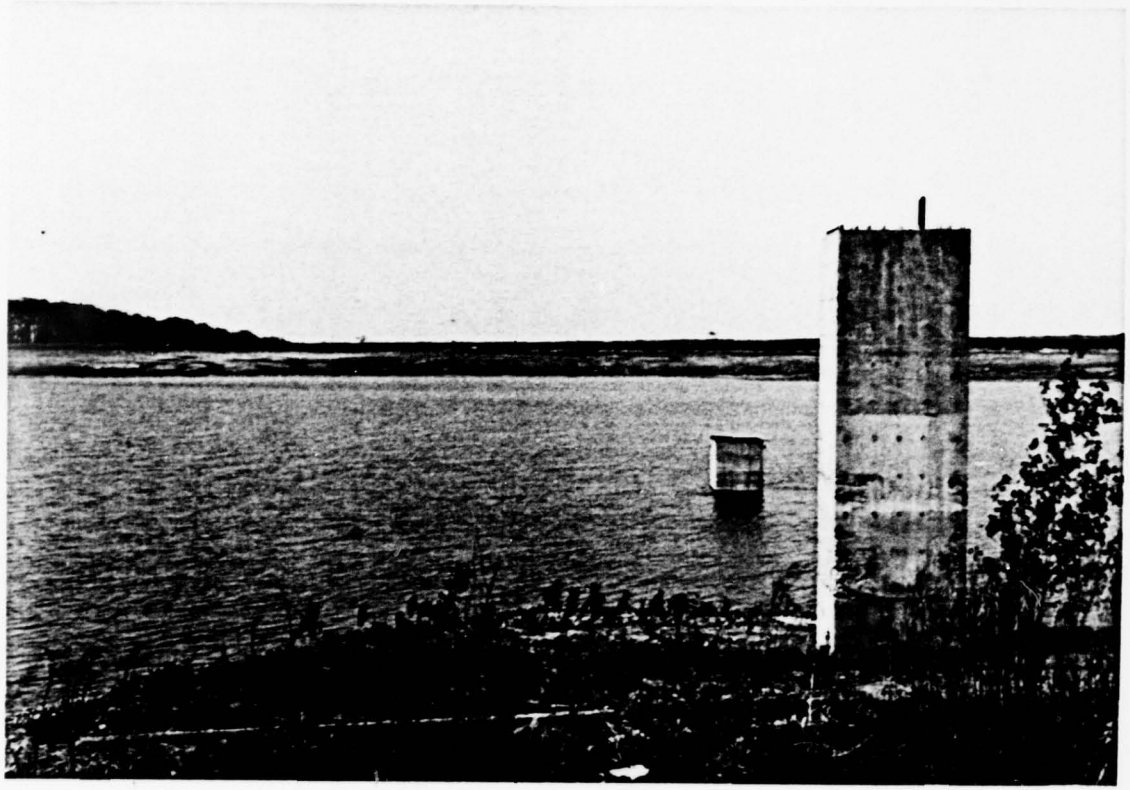
BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: July 13, 1979

APPROVED BY:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

DATE 28 July 1979



OVERVIEW

CORNWALL TAILINGS DAM

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CORNWALL TAILINGS DAM

NDI-ID NO. PA-00597
DER-ID NO. 38-87

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

Cornwall Tailings Dam was constructed by the Bethlehem Mine Corporation as a settlement basin for their tailings from a nearby iron ore mine operation. The mine was closed in 1977 and the facilities of the dam are presently not in use. At the time of inspection, it was estimated that the top of the dam is approximately at elevation 908 and the pool level was at elevation 890. The U-shaped embankment is 3800 feet in length (Refer to Plate III, Appendix F). The northern part of the embankment, which spans the original valley, is about 1900 feet long and has a maximum height of 200 feet above the downstream toe. The remainder of the embankment closes off lower areas on the east side of the reservoir with heights varying up to 60 feet. Most of the embankment was constructed from trap rock, with the exception of an impervious upstream toe and upstream blanket. There is no spillway. The only outlet is a 20-inch decant line which returned water to the mine. At present, this line is closed off near the downstream toe.

B. Location: Cornwall Borough, Lebanon County
U.S.G.S. Quadrangle, Lebanon, PA
Latitude 40°-16.5', Longitude 76°-22.8'
(Appendix F, Plates I and II)

C. Size Classification: Large (200 feet high, 667 acre-feet)

D. Hazard Classification: High (Section 3.1.E)

E. Ownership: Bethlehem Mines Corporation
Martin Tower
Bethlehem, PA 18016

F. Purpose of Dam: Settlement basin for mine tailings

G. Design and Construction History

Cornwall Tailings Dam was designed by the Bethlehem Cornwall Corporation, a subsidiary of Bethlehem Steel Corporation. The foundation investigation, soils and geologic report, stability and seepage analysis were prepared by E. D'Appolinia Associates, Pittsburgh, Pennsylvania. The permit for construction was issued on March 6, 1961, and actual construction started in April of that year. The contractor, Reisinger Bros., Inc., Carlisle, Pennsylvania, completed the initial phase of construction in October, 1961. This construction was limited to an embankment length of about 700 feet, and to a finished crest elevation of 805 (Plate VI, Appendix F). This initial phase was constructed of impervious material and is now incorporated in the dam as the upstream toe.

The subsequent raising of the dam to the design crest elevation of 910 was constructed by the owner when additional tailing storage was required.

H. Normal Operating Procedures

The tailing pond is not in use at the present time. Representatives of the owner stated that the reservoir water level has dropped since becoming inactive due to evaporation and seepage.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

From files:	0.16
Use:	0.16

B. Discharge at Dam Site (cubic feet per second)
See Appendix C for hydraulic calculations

Maximum known inflow, June 22, 1972 from records for the U.S.G.S. gaging station on a nearby creek	230

Outlet works at pool Elev. 889.7 (presently inoperative)	28
Spillway capacity	No Spillway

C. Elevation (feet above mean sea level)

Top of dam	908
Spillway crest	No Spillway
Streambed at toe of dam - estimate from inspection survey	708

D. Reservoir (miles)

Length of pool	0.3

E. Storage (acre-feet)

Top of dam (Elev. 908.0)

Tailings	3,213
Water (estimated)	667
Present pool level (Elev. 889.7) Water surface estimated from inspection survey	40

F. Reservoir Surface (acres)

Top of dam (Elev. 908.0)	62
Present level (Elev. 889.7) (estimated water area)	12

G. Dam (See Appendix F, Plates III through VIII for details.

Type: Rockfill with impervious upstream blanket.

Length: 3,800 feet.

Height: 200 feet.

Top Width: Main embankment - 100 feet.
Other sections - 30 feet.

Side Slopes: Design (See Plate IV, Appendix F)
Upstream: 2H to 1V
Downstream: 1.75H to 1V with one berm.

Survey (See Plate A-II, Appendix A)
Upstream: All covered with tailings (silt) to elevation 903±.
Downstream: Varies between 1.1H to 1V and 1.7H to 1V. Several wide berms. Average slope from top to toe 1.95H to 1V (Waste Rock 4"±).

Zoning: Impervious upstream toe to elevation 805 and a 10 foot impervious blanket above that elevation as per design drawings.

Impervious Core: None, see Zoning.

Cutoff: None. An intercepting lateral 8-inch seepage drain was installed under the embankment, backfilled with reject rock. This drain outlets through a 12-inch drain near the toe of the dam.

Grouting: None.

H. Outlet Facilities

At the present time, the only operating outlet from this reservoir is the underdrain of the dam embankment. This drain discharges about 0.3 cfs to Bernhard Creek. The drain is uncontrolled.

When the mine was operating (prior to 1977), the water level in the reservoir was controlled by the tailings deposit system. A pipe running along the top of the dam discharged a mixture of water and mine tailings into the reservoir. Decant towers at the upstream end of the reservoir collected the clear water and returned it to the mine workings via a 20-inch welded steel pipe. This pipe is now shut off and buried. If feasible, overflow for the reservoir could be provided by uncovering the 20-inch pipe. The water would return to Bernhard Creek via an an existing ditch.

I. Spillway

This dam does not have a spillway.

J. Regulating Outlets

See Section 1.3.H.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Hydrology and Hydraulics

The files of Pennsylvania Department of Environmental Resources (PennDER) or the files of the owner did not contain information concerning the hydrologic and hydraulic design of this dam. Due to the small drainage area, the function of the reservoir, and the presence of a 20-inch return line to the mine, a hydraulic analysis was not performed.

B. Embankment

The preliminary design of the embankment and the subsurface soils investigation was prepared by E. D'Appolinia Associates, Pittsburgh, Pennsylvania. A report written by this company includes a geologic report, seepage calculations and stability analysis for the main embankment. Based on this report, Bethlehem Cornwall Corporation prepared the design drawings. The embankment was constructed in several phases. The first phase consisted of an impervious embankment with a crest elevation of 805 (Plate VI, Appendix F) and the placing of an 8-inch seepage drain under the future extension of the embankment. This lateral 8-inch drain discharges into a 12-inch drain running to the downstream toe. A 24-inch pipe was installed under the embankment as a temporary diversion. This pipe was filled with lean concrete after the first phase was completed. Mine waste was brought to the reservoir through a 12-inch pipe. The clear water was taken from the reservoir at decant towers through a 20-inch pipe. This pipe would be extended upstream in the reservoir with additional decant towers if tailings would cover the first two constructed decant towers. When the decant tower was abandoned, the 20-inch pipe inlet was sealed with a steel plate and part of the tower was plugged with concrete. The 20-inch decant line led to a valve house near the downstream toe. A 6-inch pipe with a valve is tapped into the line and could be used for minimum flow requirements in Bernhard Creek. The 20-inch pipe was reduced to a 16-inch pipe in the valve house and could be closed off with a valve on this pipe. This 16-inch pipe was the return line to the mine.

The report on "Design Consideration" for this dam by E. D'Appolinia considered flow net patterns under the dam for the condition with a pool level of 739 and no sedimentation. The estimated seepage was 25,600 gallons per day. Another flow net using a pool level of 820 with tailings up to elevation 815 indicated a seepage flow of 2,000 gallons a day, due to the sealing effect of the tailings. The downstream design slope was 1.75H to 1V and one berm giving a factor of safety against sliding of the downstream slope of 4.13. The report stated that the material probably would stand to a slope of 1.5H to 1V. All pipes under the dam were placed on concrete pads and have antiseepage collars.

C. Appurtenant Structures

This facility has no spillway and the only appurtenant structures are the decant towers and a 20-inch decant pipeline with valve house. See previous section for discussion.

2.2 CONSTRUCTION

Progress reports in the PennDER files indicate that the first phase was constructed as shown on Plate VI, Appendix F. The dam was raised to its final elevation in stages as required for tailing storage or as waste rock was available. Construction records are not available. A photograph taken in 1970 shows two 6-inch pipes projecting out of the slope about 20 feet above the toe having a small discharge. Origin of water is unknown and these pipes were dry at the time of the inspection. Additional decant towers were constructed and the 20-inch pipe was extended as needed.

2.3 OPERATION

Records of operation were not located and the facilities are not in use at the present.

2.4 EVALUATION

A. Availability

The available information was obtained from the files of PennDER and include a design report, construction drawings, and construction specifications for the first phase. Some of this information is also available in the offices of the owner.

B. Adequacy

1. Hydrology and Hydraulics

No information was located concerning the hydrologic and hydraulic design for this dam. Other available information and the visual inspection are, however, considered sufficient to review the adequacy of the structure.

2. Embankment

The available information is considered to be sufficient to review the design criteria and analysis of the embankment.

3. Appurtenant Structures

The information located in the PennDER files are considered to be adequate to review the design of these structures.

C. Operating Records

There are no operating records on file with D.E.R. or the owner.

D. Post Construction Changes

The construction permit was issued for a dam with a maximum height of 158 feet and a crest elevation of 910. Refer to Section 1.2.G for design and construction history. The embankment was constructed in stages over some 15 years and although variations occurred from the original drawings, the main elements were not changed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of Cornwall Tailings Dam is good. The reservoir, constructed by Bethlehem Steel Corporation as a settlement basin, is not in active use at the present time. Only a small pool of water exists in the south end of this reservoir. The depth of the reservoir is unknown and can only be estimated. It appears that a large amount of storage is available. There is no spillway or functionable discharge line. At the time of inspection, the pool level was about 18 feet below the top of the dam.

The inspection team was accompanied by two representatives of the owner during part of the time. The visual inspection check list is in Appendix A of this report. Photographs taken during the inspection are reproduced in Appendix E.

B. Embankment

The crest of the dam is about 3,800 feet long and is U-shaped (see Appendix F, Plate III). The highest section of the abutment is located at the north end of the reservoir. A typical section was surveyed and a schematic plan and survey section is shown in Appendix A, Plates A-I and A-II. A crest profile was not made during the inspection.

The main section has a crest width of about 98 feet, appears to be level and well compacted and is covered with grass and small weed growth. The upstream slope is mostly covered with silt deposits and slopes gently to the water surface about 600 feet upstream from the crest. The 98 foot wide crest has a rock dike at the downstream side, over most of its length. This rock pile is about 3 feet high and presumably was constructed as a safety barrier for trucks.

The downstream slope is steep (Plate A-II) and has several benches of variable width. The slope is all exposed waste rock (Appendix E, Plate E-1). The height of the fill at its maximum section is about 200 feet. Some water was seeping out of the embankment near the drain pipe which has been installed under the fill. The estimated flow is .3 cfs.

The major length of the dam has an estimated height from 30 to 60 feet maximum and has a similar rock dike and downstream slope.

C. Appurtenant Structures

As previously mentioned, this dam does not have a spillway. The fine (silt) crusher waste of the mine was pumped to the reservoir through a 12-inch pipe. After the silt settled out, the clear water was returned to the mine for reuse by gravity through a 20-inch welded steel pipe.

Two intake decant towers are still visible. Both towers have an open flange 20-inch pipe through which the water could enter if the pool level would reach the invert elevation. A valve house was located near the downstream toe from which a 6-inch tap line could discharge water into an open ditch to the natural stream. This valve house was destroyed by vandalism and the owners have filled the valve pit with sand and gravel to prevent unauthorized use of the valves. The location of the valve pit is known to the owners.

D. Reservoir Area

The reservoir area is mostly banks formed from silt with some brush growth. The drainage area is wooded outside of the actual reservoir.

E. Downstream Channel

The downstream channel is the natural stream (Bernhard Creek) with several houses close to the stream and close to the embankment fill. About 2,000 feet downstream from the dam, the stream runs through the town of Rexmont with several homes located close to the stream. If the dam would fail due to overtopping, it is expected that the hazard to loss of life would increase. The hazard category for this dam is considered to be "High".

3.2 EVALUATION

The general appearance of the dam is good. The available storage in the reservoir is considerable for the size of the drainage area (less than .2 square miles). Based on the visual inspection it appears very unlikely that the reservoir would ever fill. Evaporation and normal leakage will probably control the pool level. The length of the embankment, the width of the crest and type of rock on the downstream slope all indicate that a relatively large outflow could be handled over the embankment without a chance of failure. Calculations to confirm any of these assumptions have not been made.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURE

Bethlehem Steel Corporation closed the mining facilities near Cornwall in 1977 and no active use is being made of this reservoir. At present, there are no operational procedures for this facility.

4.2 MAINTENANCE OF DAM

Maintenance is not being performed at the dam. The downstream slope has a rock surface without any growth at the present time. The crest of the dam is either bare stone and gravel or overgrown with low weeds.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only operating facilities are the two decant towers and the 20-inch decant line with valve control near the downstream toe. The control valve has been buried and maintenance has not been performed since 1977.

4.4 WARNING SYSTEM

Although the property is guarded and surrounded by a fence, no formal surveillance or downstream warning system exists. It appears that visits to the embankment only occur very occasionally.

4.5 EVALUATION

Formal maintenance procedures do not exist and are not required at the present time. Brush and tree growth should be prevented on the downstream slope, the crest and the upstream slope near the crest. It is recommended that a formal surveillance and downstream warning system be developed for implementation during periods of high or prolonged precipitation.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analyses available from the PennDER file for Cornwall Tailings Dam was not very extensive. No frequency curve, unit hydrograph or flood routing was available. There was a stage vs. total volume curve for the reservoir.

B. Experience Data

Because of the large storage volume of the reservoir and the small size of the drainage area there has never been a flood problem at this project. Since the mine ceased operation in 1977, the combined effects of the 0.3 cfs of embankment drainage and of the evaporation from the pool have kept the pool contents at a small percentage of the available storage.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the project could not operate satisfactorily during a flood event.

D. Overtopping Potential

The calculations in Appendix C indicate that there is a minimum possibility of overtopping. The inflow of one full PMF (Probable Maximum Flood) would raise the existing pool elevation of 890 to about elevation 899, leaving a freeboard of 9 feet. The storage requirements for one PMF is 251 acre-feet, the present storage capacity is estimated at 667 acre-feet or sufficient to store the PMF. Calculations indicate that evaporation and leakage on an annual basis equals the yearly inflow. It is, therefore, considered that overtopping potential does not exist.

E. Spillway Adequacy

There is no spillway. The reservoir is considered to be adequate in storage capacity. Annual evaporation and leakage is estimated to be equal to the annual inflow.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observation

1. Embankment

A report prepared by E. D'Appolonia Associates, dated October, 1960 describes the preliminary design considerations for the construction of the embankment. The recommended ratio for the design of the downstream slope was 1.75H to 1V and for the upstream slope 2H to 1V. It was noted that the slope ratios on the downstream slope will stand on slopes of 1.5H to 1V and that the actual slopes will depend on the stability of the rock materials in the slope.

The slope measurements made during this inspection are shown on Plate A-II in Appendix A. This section shows the slope above the uppermost bench to the top of the dam to be 1.7H to 1V, (H = 82'±); the slope to the next lower bench is 1.1H to 1V, (H = 35'±); the next lower slope is 1.4H to 1V, (H = 72'±); and the remainder of the slopes between two narrow benches is 1.5H to 1V (combined H = 15'±). An overall slope line from the top to the downstream toe of the embankment indicates a ratio of 1.95H to 1V.

The elevation of the uppermost bench varies, because this wide bench was used as an access road to the top of the dam from aa elevation of about 795.

The visual inspection of the downstream slope did not reveal any evidence of instability. The rock slope surfaces appear to have stabilized with varying slope angles between the 1:1H to 1V and 1:7H to 1V range dependent upon the size of the rock and the amounts of fine stone in a particular area. When considering the dimensions of the entire downstream portion of the embankment, 395±H to 203±V, the benches do aot appear to be significant in the evaluation of the slope stability. The overall top to toe slope is flatter than the recommended 1.75H to 1V. This fact, together with the observed conditions indicates that the embankment slopes are stable.

The upstream slope is flatter than 2H to 1V and is also considered to be stable. The crest of the dam has a width of 98 feet rather than the design width of 30 feet.

2. Appurtenant Structures

The only visible part of these structures were two decant towers in the upstream area of the reservoir and the 12-inch outlet of

the drain pipe. All structures appeared to be in good condition. A boat would be required to inspect the tower located in the reservoir. The owner's representative stated that a standpipe was located in this tower on the decant line. The inflow elevation is unknown.

B. Design and Construction Data

1. Embankment

The available engineering data includes a report prepared by E. D'Appolonia Associates. This report describes the details of investigations and engineering calculations that were made regarding seepage and stability of the embankment.

The project was constructed in stages as the waste materials from the mining (iron ore) became available. There are no records of construction of this dam.

The available engineering data indicates that the design was prepared according to accepted engineering data. The stability against sliding, according to the calculations, are well above minimum requirements for safety. The only exception made is that sliding was considered on a horizontal plane, with a maximum dam height of 158 feet (elevation 752 to 910). However, the actual toe of the dam is at elevation 708± and the valley dips nearly 44 feet in 800 feet and no consideration of sliding of the decomposed diabase in a saturated condition was made. The sloping plain will reduce the factor of safety against sliding slightly but is still considered adequate.

2. Appurtenant Structures

There is no spillway and it appears that the decant pipe and towers were designed and detailed in accordance with acceptable engineering standards.

C. Operating Records

Record of operation have not been maintained. Representatives of the owner did not recollect any problems affecting the safety or stability of the structures.

D. Post Construction Changes

The present embankment has been constructed in stages over a period of 15 years. No changes have been made since the dam was completed in 1977.

E. Seismic Stability

This dam is located in Seismic Zone 1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. No studies or calculations have been made to confirm this assumption.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection and the review of available design data indicates that Cornwall Tailings Dam is in good condition and has been designed in accordance with acceptable engineering practice.

Although this dam does not have a spillway, the present storage capacity of the reservoir can handle the PMF without overtopping. The yearly inflow of the small drainage area nearly balances with the expected evaporation and seepage losses and no increase in pool level is expected. The type of embankment with its rock slopes could also withstand some overtopping without endangering the stability. For these reasons, the facilities are considered to be satisfactory.

B. Adequacy of Information

The information available for review is considered to be adequate to make a reasonable assessment of these facilities.

C. Urgency

It is considered that the recommendations in this section should be implemented as soon as practical.

D. Necessity for Additional Studies

Additional studies are not required at this time. However, attention should be given to the recommendations presented below.

7.2 RECOMMENDATIONS

A. Facilities

There are no special recommendations for the overall facilities. Recommendations are related to operation and maintenance procedures.

B. Operation and Maintenance Procedures

The following operations are presented for implementation by the owner:

1. That a staff gauge be installed on the decant tower located in the pool and that at least monthly readings be taken to establish records of changes in the pool level.

2. That the 6-inch blowoff valve on the decant pipe be located and made operable for use in the event of an emergency.

3. That a formal surveillance and downstream warning system be developed for implementation during periods of heavy or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 38-87 NDI NO. PA-00597

NAME OF DAM Cornwall Tailings Dam HAZARD CATEGORY High

TYPE OF DAM Rockfill with impervious toe section & upstream blanket.

LOCATION Borough of Cornwall ~~TOWNSHIP~~ Lebanon COUNTY, PENNSYLVANIA

INSPECTION DATE 5/11/78 WEATHER Sunny - Warm TEMPERATURE 70's

INSPECTORS: R. Houseal (Recorder) OWNER'S REPRESENTATIVE(s):

R. Steacy Charles Neil

A. Bartlett Ned Kiscadden

H. Jongsma

NORMAL POOL ELEVATION: N/A AT TIME OF INSPECTION:

BREAST ELEVATION: 908.0 (Estimated) POOL ELEVATION: 889.7

SPILLWAY ELEVATION: N/A TAILWATER ELEVATION: 703

MAXIMUM RECORDED POOL ELEVATION: Unknown

GENERAL COMMENTS:

This is not a conventional dam with spillway, outlet, etc. The reservoir was used for storage of silt which was a waste product of iron ore mining.

NDI NO. PA-00 597

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None.
B. UNUSUAL MOVEMENT BEYOND TOE	None.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	 Curved and several sharp angles. Not surveyed.
E. RIPRAP FAILURES	None.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Good.
G. SEEPAGE	Designed for seepage by underdrain to supply minimum flow. About 2 gallon per second from pipe. No seepage from embankment.
H. DRAINS	Lateral and a traverse drain. Two 6-inch pipes about 12 feet above toe. Refer to Appendix F for plans.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Waste rock on downstream slope. Upstream slope - silt covered - very flat slope. Several bushes on 100-foot wide crest. Top - grassed area with some fine stones.

NDI NO. PA-00 597

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Two decanter towers tied to 20-inch pipe. Probably only one open.
B. OUTLET STRUCTURE	As near as could be determined in conversation with owner's employees, this structure was vandalized and burned some time ago and was subsequently buried under sand and rock.
C. OUTLET CHANNEL	Natural stream.
D. GATES	None.
E. EMERGENCY GATE	None.
F. OPERATION & CONTROL	None.
G. BRIDGE (ACCESS)	None.

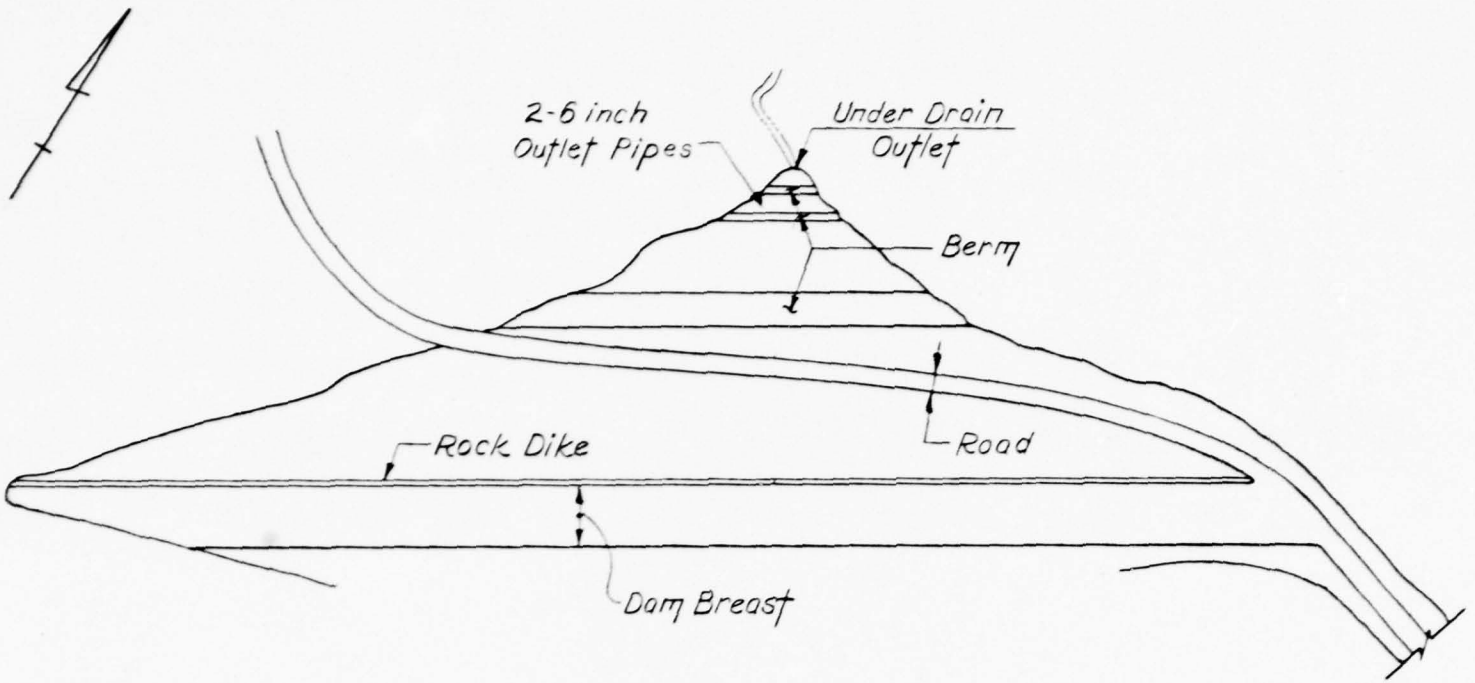
NDI NO. PA-00 597

VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	None - discharge comes directly from reservoir. Design considered seepage and evaporation as control.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	None.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	None.
D. BRIDGE & PIERS	None.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	None.

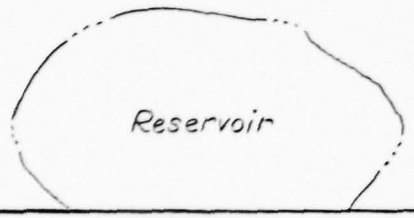
VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
RESERVOIR Slopes	Silt and exposed ground - some trees.
Sedimentation	Silt accumulation (this is the purpose of reservoir)
Watershed Description	Woodland and the reservoir itself.
DOWNSTREAM CHANNEL Condition	Small village (Rexmont) downstream.
Slopes	Wooded over 500 feet, then houses.
Approximate Population	100
No. Homes	25



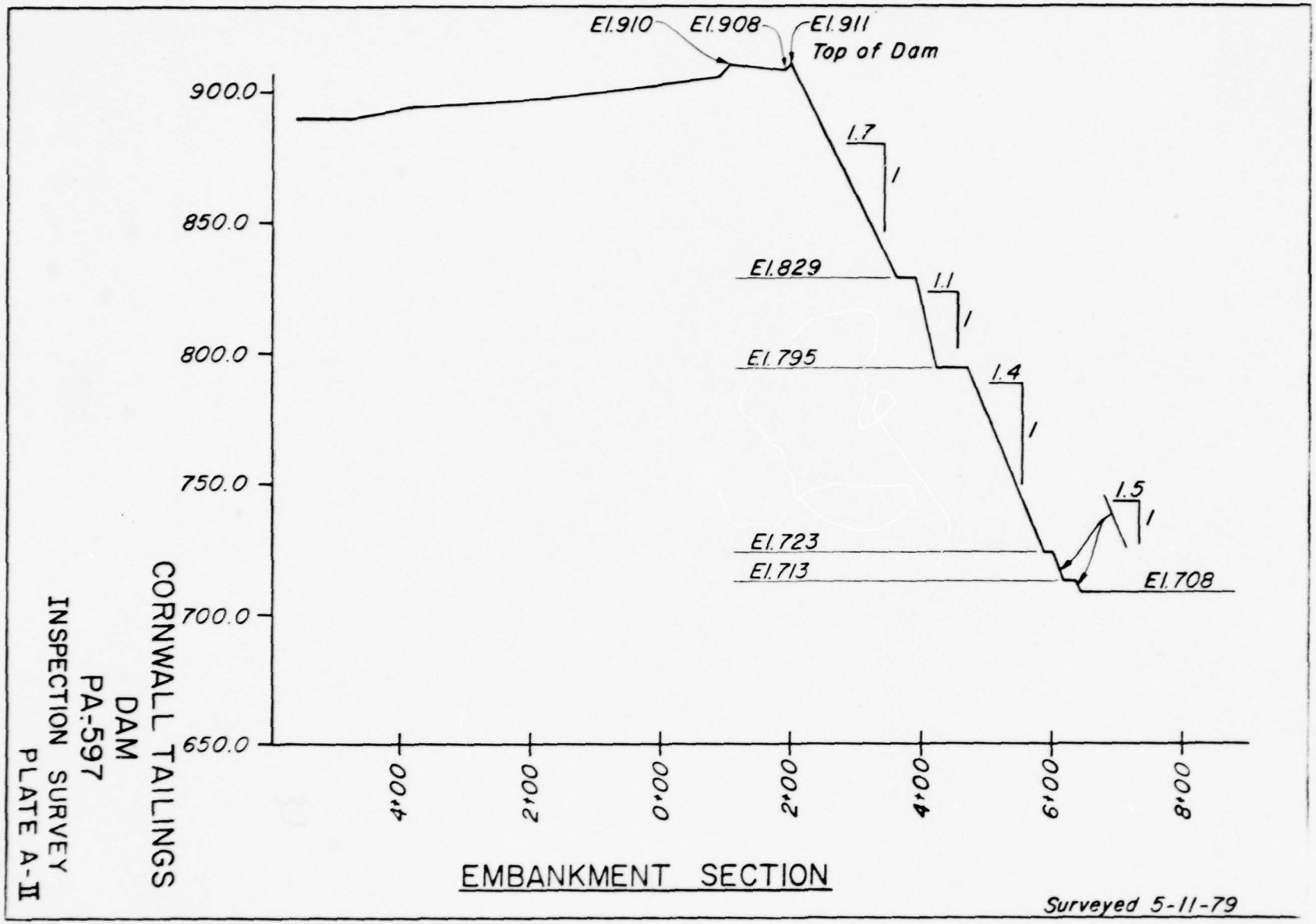
SILT DEPOSIT

PLAN-CORNWALL TAILINGS DAM



Surveyed 5/11/79

CORNWALL TAILINGS
DAM
PA. 597
INSPECTION SURVEY
PLATE A-I



CORNWALL TAILINGS DAM
PA-597
INSPECTION SURVEY
PLATE A-II

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 38-87 NDI NO. PA-00 597

NAME OF DAM Cornwall Tailings Dam

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle, Lebanon, PA See Plate II, Appendix F
CONSTRUCTION HISTORY	Construction of first phase started in 1961 and completed that year. Contractor - Reisinger Bros., Inc., Carlisle, PA. Embankment raised from original elevation 805 to present elevation 908±.
GENERAL PLAN OF DAM	See Appendix F, Plate III.
TYPICAL SECTIONS OF DAM	See Appendix F, Plate IV.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	None active at present. This tailings dam had a 20-inch decanter line, which is closed off by a valve near the downstream toe.

NDI NO. PA-00 597

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None.
DESIGN REPORTS	"Design Consideration" by E. D'Appolinia, Pittsburgh, PA., in PennDER file.
GEOLOGY REPORTS	See report by E. D'Appolinia.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	 None. See report by E. D'Appolinia. See report by E. D'Appolinia.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	 See Appendix F, Plate VII. See report by E. D'Appolinia. Additional borings in PennDER files.
POST CONSTRUCTION SURVEYS OF DAM	None available.
BORROW SOURCES	Upstream toe formed from material out of reservoir. Main dam formed by trap rock from mine.

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	None, except downstream slope was placed on natural slope.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	None.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	No spillway.

NDI NO. PA-00597

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	See Appendix F, Plates III, V and VI. Valve house is presently buried.
CONSTRUCTION RECORDS	Monthly progress records for first phase to elevation 805.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	None.
MISCELLANEOUS	

BY RLS DATE 6/8/79
CHKD. BY ____ DATE ____
BERGER ASSOCIATES

NDI NO. PA-00 597

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Small area above reservoir. All wooded.

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 890 62 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev. 908 667 Acre-Feet

MAXIMUM DESIGN POOL: Elev. None

TOP DAM: Elev. 908±

SPILLWAY:

No Spillway

a. Elevation

b. Type

c. Width

d. Length

e. Location Spillover

f. Number and Type of Gates

OUTLET WORKS:

a. Type 20-inch decanter line.

b. Location Left abutment.

c. Entrance inverts 890±.

d. Exit inverts None.

e. Emergency drawdown facilities 6-inch valve on 20-inch line. ~~Buried at present~~

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: Unknown.

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 28 FEB 79

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

CORNWALL TAILINGS DAM **** BERNHARD CREEK
BOROUGH OF CORNWALL, LEBANON COUNTY, PA

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.

- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

PROJECT Dam Investigation SHEET NO. 1 OF

SUBJECT Cornwall Tailings Dam, ID No. 597

COMPUTED BY RES DATE May 29, 1979 CHECKED BY JJPL

Maximum Known Flood

At USGS Gaging Station Beck Creek near Cleona, Max Flood 1963-1976 was 5,150 cfs, June 22, 1972, Drainage Area = 7.87 Sq. mi.

Estimate maximum inflow to Tailings Dam Reservoir

$$\left(\frac{0.16}{7.87}\right)^{0.8} \times 5150 = 230 \text{ cfs} \quad 6\text{-}22\text{-}72.$$

Estimated surface area of water in reservoir.

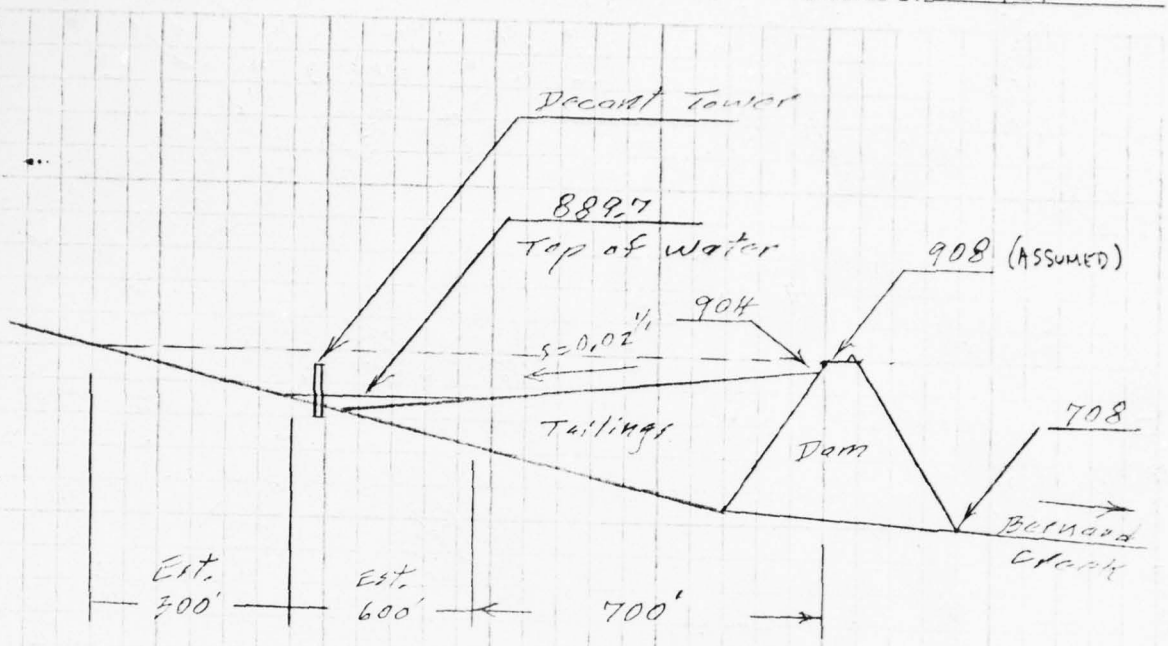
Over the years, a mixture of tailings and water has been introduced to the reservoir from various openings in a pipe stretched along the top of the dam. The tailings dropped out of the mixture and formed an incline with the highest elevation near the dam and the lowest at the upstream side of the reservoir. Water was removed through decant towers at the upstream side of the reservoir and returned to the plant to pick up more tailings. The system has been out of operation since 1977. At the present time there is a pond at the upstream side of the reservoir which is estimated to cover 20 percent of the total reservoir area or 0.2 x 62 = 12 acres. The remaining 50 acres is occupied by the inclined fill of tailings whose top surface is above the elev. of water surface. By levels at 5-11-79, it was determined that the present pond is at elev. 882.7 (is the top of dam is at elev. 908). The top of the tailings deposit next to the dam is at (elev. 904.

It is estimated that the present pond has a maximum depth of 10 feet.

PROJECT Dam Investigation SHEET NO. 1 OF

SUBJECT Cornwall Tailings Dam ID No. PA - 179

COMPUTED BY RES DATE June 1, 1979 CHECKED BY JJPJr



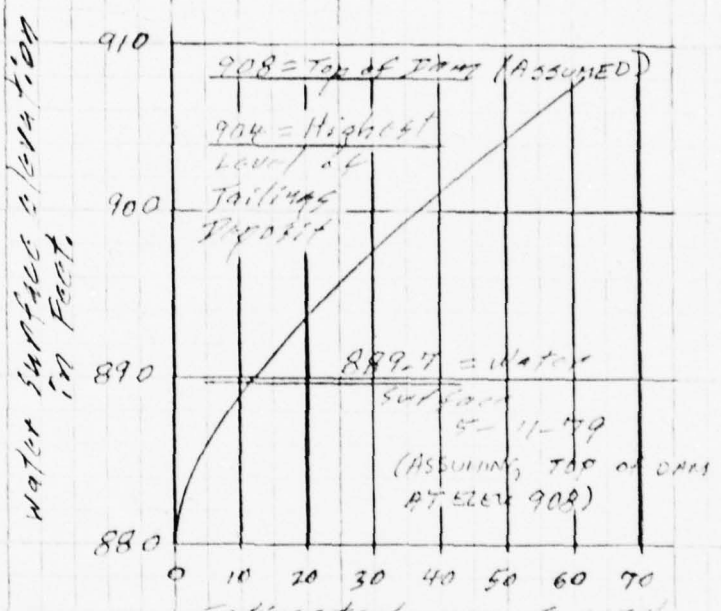
No Scale

PROJECT Dam Investigation SHEET NO. 2 OF

SUBJECT Cornwall Tailings Dam, ED Nr. 1977

COMPUTED BY RES DATE May 29, 1979 CHECKED BY JJP Jr

Estimated surface area of water in Reservoir (cont).



Estimated volume of water in pond on top of tailings deposit

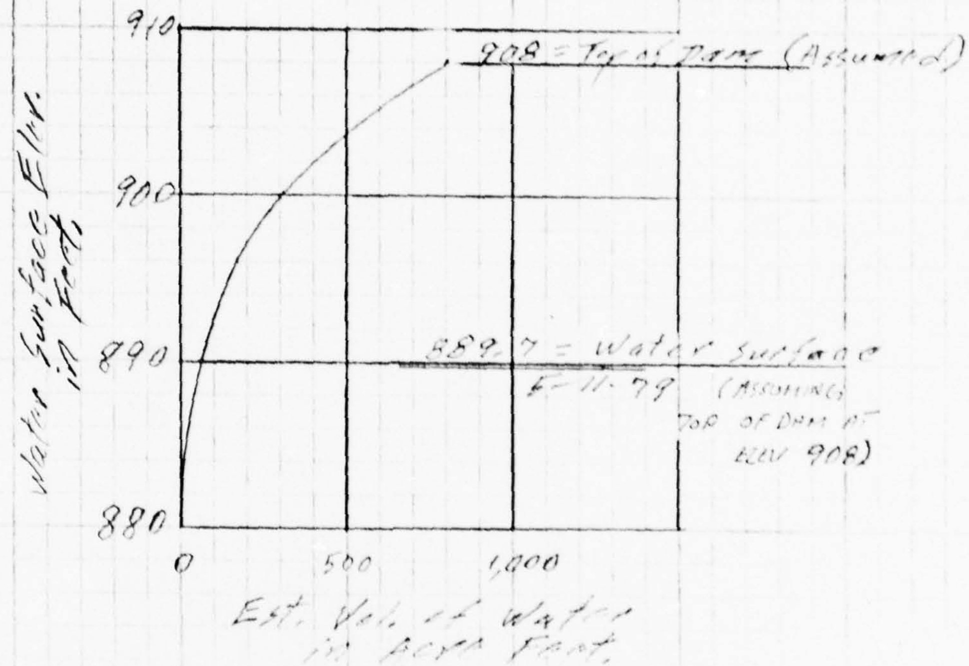
Elev.	Area Acres	Av. Area ± √A1A2	Height Ft	Vol Ac Ft	Tot Vol Ac Ft
880	0				0
		0	10	40	
890	17				40
		21	10	234	
900	37				274
		48	8	393	
908	62				667

PROJECT Dam Investigation SHEET NO. 4 OF

SUBJECT Cornwall Tailings Dam, ID No. [illegible]

COMPUTED BY RES DATE May 29, 1979 CHECKED BY JJPJr

Estimated Volume of Water in Pond on Top of Tailings Deposit (Cont.)



Evaporation From Lake Surface

U.S. Weather Bureau Technical Paper No. 37 "Evaporation Maps for the United States" Plate 2, "Average Annual Lake Evaporation in Inches" gives 34 inches for this location.

Use 34 inches annually

34 ÷ 12 = 2.83 ft annually

Seepage From Reservoir

This dam was built about 1961. Information in the files of the owner indicates that measured seepage was 320 gallons per minute or 0.71 cfs in 1964.

On May 11, 1979, the seepage flowing from the toe of the dam was measured and found to be 0.3 cfs = 217 acre feet per year. Use this figure.

PROJECT: Dam Investigation — SHEET NO. 2 OF ____

SUBJECT: Cornwall Tailings Dam, ID No. 597

COMPUTED BY: RES — DATE: May 29, 1979 — CHECKED BY: [illegible]

Estimate of Future changes in Water Surface Elevation.

The mining operation has been shut down since 1977, and, at the present time, the owner does not expect to add any water to the pond, nor does he expect to drain any water from the pond. The owner's representative reports that the pond has been gradually losing water.

This statement is checked in the calculations below by assuming that the change in pond water volume is equal to the precipitation inflow minus the evaporation and minus the seepage. Inflow is calculated from runoff figures for the USGS gaging station Bex Creek near Cleona.

Cleona Gage

Water Year	Runoff in inches	Water Year	Runoff in inches
1964	9.64	1971	13.59
65	4.84	72	27.72
66	4.33	73	19.21
67	9.14	74	15.08
68	12.79	75	17.81
69	9.31	76	19.31
70	14.93	77	16.24

14) 193.94 = 13.9

Reservoir 62 acres.

Entire basin = .16 sq mi = 102 acres

Wooded area = 102 − 62 = 40 acres

Use 40 inches runoff for reservoir (100% Av. Rainfall)

(Rainfall × Resv. Area) + (Av Runoff × Wooded Area) ÷ Tot. Area = Weighted Runoff

$$\frac{(40 \times 62) + (13.9^{*} \times 40)}{102} = 30 \text{ inches weighted runoff}$$

Inches × 53.33 × Sq. Mi. = Acre Ft. of Runoff

30 × 53.33 × 0.16 = 256 Ac Ft weighted runoff.

* Runoff from wooded area based on runoff at Cleona gage

PROJECT Dam Investigation SHEET NO. 6 OF
SUBJECT Cornwall Tailings Dam, ID No. 134
COMPUTED BY RES DATE May 29, 1979 CHECKED BY JJPS.

Water Year	Inflow Ac. Ft.	Area Acres	Evap. Ac Ft	Seepage Ac. Ft.	Yr. End Ac Ft	Yr End Elev.
1978					60	889.7
1979	256	12	34	217	65	890.0
1980	256	12	34	217	70	890.8
1981	256	13	37	217	72	891.2
1982	256	14	40	217	71	891.1
1983	256	14	40	217	70	890.8

Evaporation = 2.83 x area in acres.

The above calculations use precipitation and runoff figures for an average year. They show that the pond elevation may be expected to rise a foot or two in a wet year and to fall a foot or two in a dry year. The rise or fall of the pool tends to be self limiting since a larger pool would increase the loss due to evaporation.

At the present level, the reservoir has sufficient capacity to hold the runoff from about three average years without any allowance for seepage and evaporation.

This storage capacity can also be expressed as 86 inches of runoff or over three times the 26 inches of runoff sometimes used as the size of a Probable Maximum Flood.

PROJECT: Dam Investigation SHEET NO. 1 OF

SUBJECT: Cornwall Tailings Pond, ID No. 697

COMPUTED BY: RES DATE: May 29, 1979 CHECKED BY: JPS

Outlet Works (Evaporative)

A 20-inch welded steel decant pipe runs about 1,400 feet from a concrete decant structure in the reservoir to a buried valve 300 feet downstream from the centerline of the dam. At present, there is no flow in this pipe. If a 20-inch tee and valve could be installed* at this location, water from the reservoir could be discharged into a ditch leading to Bonnard Creek. *(FEASIBILITY OF INSTALLATION WOULD REQUIRE DETAILED STUDIES)

Calculate maximum discharge:

$$H = \left[\frac{2.5204(1+K_e)}{D^4} + \frac{466.18\,n^2 L}{D^{16/3}}\right]\left(\frac{Q}{10}\right)^2$$

From levels of 5-11-79 pool level was 889.7

From design drawing, end of 20-inch pipe is at elev. 790.

$H = 889.7 - 790 = 99.7$ ft.

$K_e = 0.5$

$D = \frac{20}{12} = 1.67$ ft.

$n = 0.017$

$L = 1,400$ ft.

$$99.7 = \left[\frac{2.5204 \times (1.5)}{(1.67)^4} + \frac{466.18 \times (0.017)^2 \times 1400}{(1.67)^{5.33}}\right]\left(\frac{Q}{10}\right)^2$$

$$= \left[0.486 + 12.26\right]\left(\frac{Q}{10}\right)^2$$

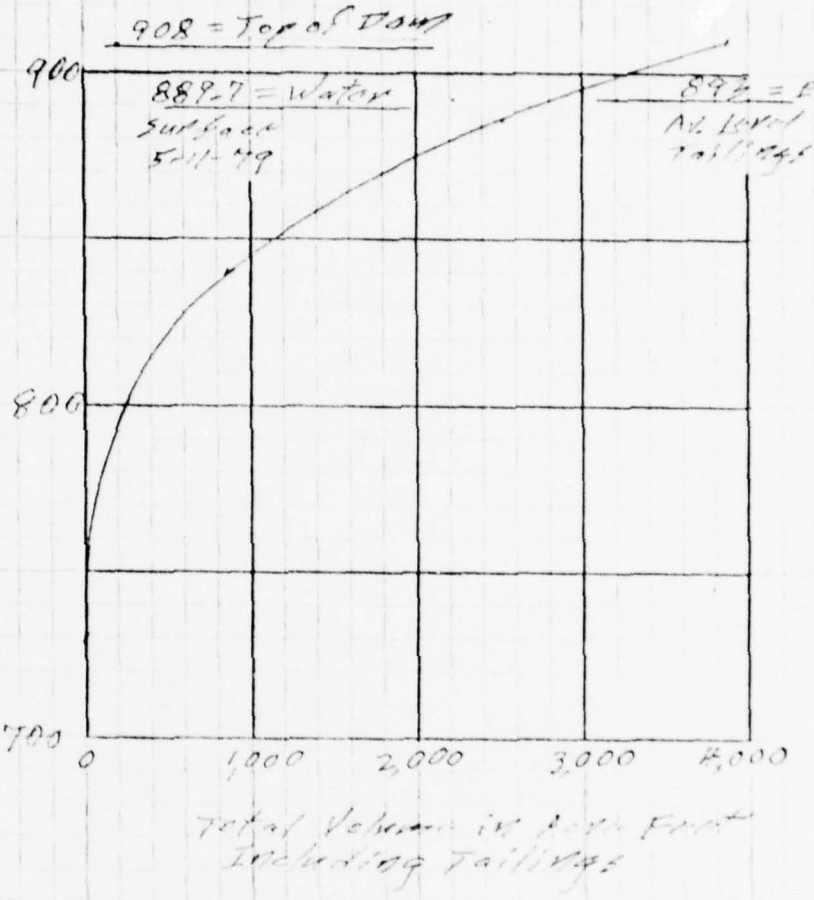
$$\left(\frac{Q}{10}\right)^2 = \frac{99.7}{12.75} = 7.82$$

$$\frac{Q}{10} = 2.80 \qquad Q = 28 \text{ cfs}$$

PROJECT Dam Investigation SHEET NO. ___ OF ___

SUBJECT Coldwell Tailings Dam, I.D. No. [illegible]

COMPUTED BY PES DATE May 22, 1979 CHECKED BY WPS



BASIN STORAGE CURVE
FROM STATE FILES

BY RLS DATE 6/8/79 | BERGER ASSOCIATES | SHEET NO. 9 OF
CHKD. BY DATE | PROJECT D 8490
SUBJECT CORNWALL TAILINGS DAM

SIZE CLASSIFICATION
MAXIMUM STORAGE = 667 ACRE-FEET
MAXIMUM HEIGHT = 200 FEET
SIZE CLASSIFICATION IS "LARGE"

HAZARD CLASSIFICATION
VILLAGE OF REXMONT LIES DOWNSTREAM OF THIS DAM.
USE "HIGH"

RECOMMENDED SPILLWAY DESIGN FLOOD
THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO THE PROBABLE MAXIMUM FLOOD.

BY RLS DATE 6/8/79 BERGER ASSOCIATES SHEET NO. 10 OF
CHKD. BY DATE PROJECT D849
SUBJECT CORNWALL TAILINGS DAM

HEC -1 DATA

DRAINAGE AREA = 0.16 SQ. MI.

SUSQUEHANNA BASIN REGION 15 B

$C_P = 0.85$

$C_T = 2.20$

L' END OF RESERVOIR TO BASIN DIVIDE = 0.23 MI.

$$T_P = C_T (L')^{.6}$$

$T_P = 0.9$

RAINFALL (HMR-33)

INDEX (200 SQ. MI. - 24 HR.) = 23.2"

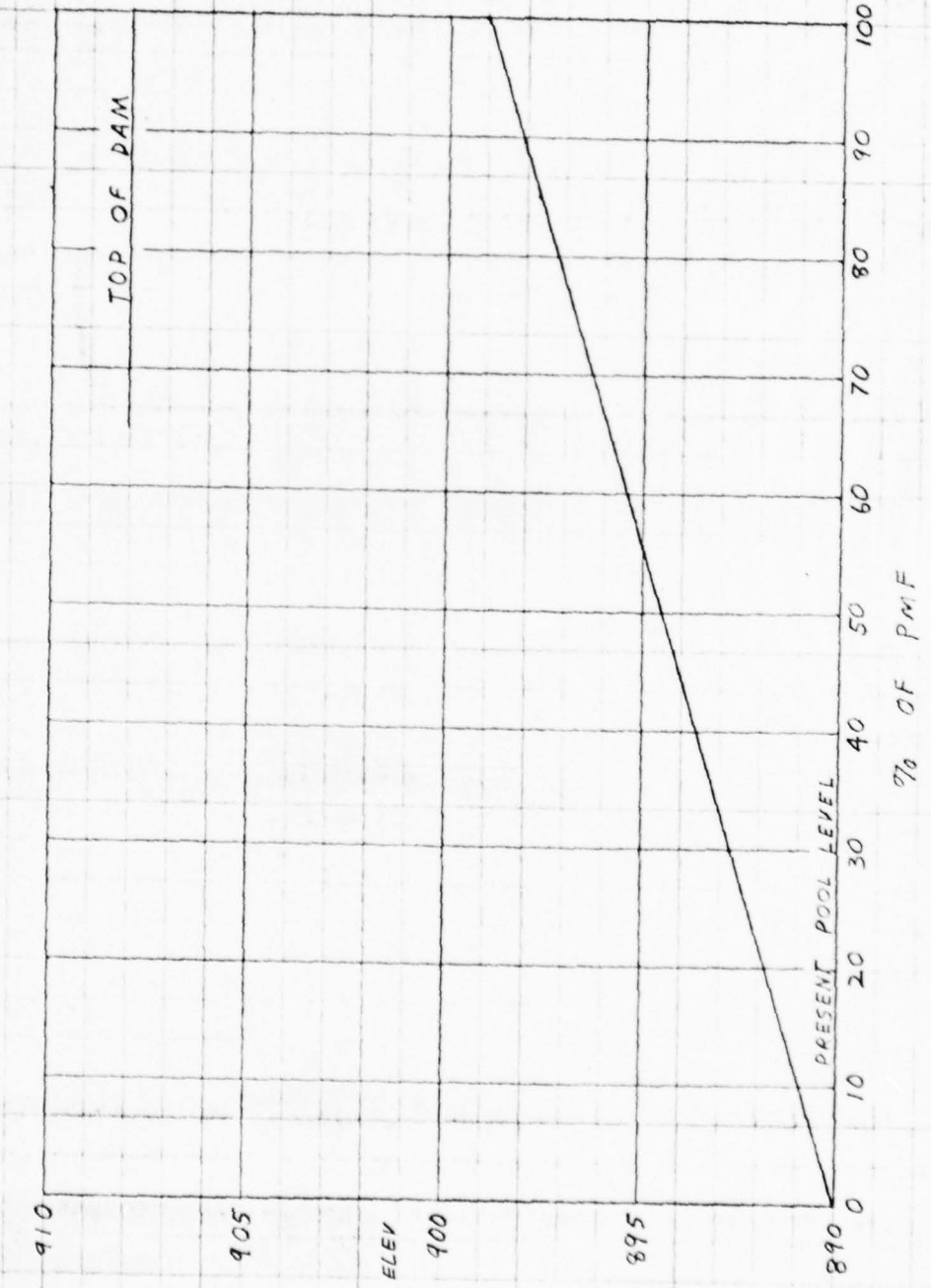
ZONE 6

INCREMENTAL RAINFALL

6 HR = 113 %
12 HR = 123 %
24 HR = 132 %
48 HR = 143 %

BY RLS DATE 6/8/79 BERGER ASSOCIATES SHEET NO. 11 OF
CHKD. BY DATE PROJECT 78490
SUBJECT CORNWALL TAILINGS DAM

CAPACITY CURVE



```
FLOOD HYDROGRAPH PACKAGE (HEC 1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************
    1            A1     CORNWALL TAILINGS  DAM    ****    BERNHARD CREEK
    2            A2     BOROUGH OF CORNWALL, LEBANON COUNTY, PA.
    3            A3     NDI # PA-00597     PA DER # 38-87
    4            B   300      0     15      0      0      0      0      0     -4      0
    5            B1    5
    6            J     1      9      1
    7            J1    1    .85     .7     .6     .5     .4     .3     .2     .1
    8            K             1                                   1
    9            K1                  INFLOW  HYDROGRAPH
   10            M     1      1    .16                                        1
   11            P           23.2    113    123    132    143
   12            T                                                 .1    .05
   13            W    .9    .85
   14            X   -1.5   -.05      2
   15            K     1      2                                   1
   16            K1                 RESERVOIR  ROUTING
   17            Y                                1      0
   18            Y1    1                                          40     -1
   19            Y4   908   908.1   908.2   908.3   908.4   908.5   908.6   908.8    909
   20            Y5     0     324     918    1686    2596    3627    4768    7341   10260
   21            $S     0      40     274     667     730
   22            $E   880     890     900     908     909
   23            $$   908
   24            $D   908
   25            K     99
1                        PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                              RUNOFF HYDROGRAPH AT          1
                              ROUTE HYDROGRAPH TO           2
                              END OF NETWORK

**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  26 FEB 79
**********************************

 RUN  DATE# 79/06/07.
      TIME# 07.18.28.

                              CORNWALL TAILINGS  DAM    ****    BERNHARD CREEK
                              BOROUGH OF CORNWALL, LEBANON COUNTY, PA.
                              NDI # PA-00597     PA DER # 38-87

                                          JOB SPECIFICATION
                                NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
                               300       0      15       0       0       0       0       0      -4       0
                                                JOPER     NWT   LROPT   TRACE
                                                    5       0       0       0

                                        MULTI-PLAN ANALYSES TO BE PERFORMED
                                             NPLAN= 1 NRTIO= 9 LRTIO= 1
                                RTIOS=  1.00    .85    .70    .60    .50    .40    .30    .20    .10
```

CORNWALL TAILINGS DAM #### BERNHARD CREEK
BOROUGH OF CORNWALL, LEBANON COUNTY, PA.
NDI # PA-00597 PA DER # 38-87

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .85 .70 .60 .50 .40 .30 .20 .10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.16	0.00	.16	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
4 TP= .90 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 9 END-OF-PERIOD ORDINATES, LAG= .90 HOURS, CP= .84 VOL= 1.00
15. 48. 80. 95. 85. 54. 23. 9. 3.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	10216.
										(674.)	(613.)	(61.)	(289.28)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IFMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	40.	-1

STAGE	908.00	908.10	908.20	908.30	908.40	908.50	908.60	908.80	909.00
FLOW	0.00	324.00	918.00	1686.00	2596.00	3627.00	4768.00	7341.00	10260.00
CAPACITY=	0.	40.	274.	667.	730.				
ELEVATION=	880.	890.	900.	908.	909.				

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
908.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
908.0	0.0	0.0	0.

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

********** ********** ********** ********** **********

of the tailings dam
by dam is at elev. 904.
It is estimated that the annual pool
has a maximum depth of 10 feet.

1 ********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

				RATIOS APPLIED TO FLOWS									
OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9	
				1.00	.85	.70	.60	.50	.40	.30	.20	.10	
HYDROGRAPH AT	1	.16	1	758.	644.	531.	455.	379.	303.	227.	152.	76.	
		(.41)		(21.47)(	18.25)(	15.03)(	12.88)(	10.73)(	8.59)(	6.44)(	4.29)(	2.15)	
ROUTED TO	2	.16	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	
		(.41)		(0.00)(	0.00)(	0.00)(	0.00)(	0.00)(	0.00)(	0.00)(	0.00)(	0.00)	

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	890.00	908.00	908.00
	STORAGE	40.	667.	667.
	OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	899.03	0.00	251.	0.	0.00	0.00	0.00
.85	897.67	0.00	220.	0.	0.00	0.00	0.00
.70	896.32	0.00	188.	0.	0.00	0.00	0.00
.60	895.42	0.00	167.	0.	0.00	0.00	0.00
.50	894.51	0.00	146.	0.	0.00	0.00	0.00
.40	893.61	0.00	125.	0.	0.00	0.00	0.00
.30	892.71	0.00	103.	0.	0.00	0.00	0.00
.20	891.81	0.00	82.	0.	0.00	0.00	0.00
.10	890.90	0.00	61.	0.	0.00	0.00	0.00

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****
EOI ENCOUNTERED.

APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Names: Hammer Creek Formation and Diabase.

Lithology: Predominantly red to brown quartz sandstone with interbeds of quartz pebble conglomerate and some red shale. The sandstone beds are typically a few inches to a foot, or more, thick. Grain size ranges from very fine to coarse. Sand grains are angular to sub-rounded quartz, imbedded in a matrix of clay and hematite. The conglomerates consist of pebbles and cobbles of quartzite, vein quartz and sandstone in a matrix of coarse sandstone, clay and hematite. The shale beds are red, thin bedded, non-fissile, composed of clay, hematite and some calcite.

Diabase is an intrusive igneous rock composed essentially of pyroxene and feldspar. Quartz, ilmenite and magnetite are common accessory minerals. The fresh rock is gray to dary gray with massive crystalline texture. Weathered surfaces are dark gray with local brown iron staining. The interlocking crystals of pyroxine and feldspar make the rock very tough and strong.

Structure

At the dam site, beds of the Hammer Creek Formation which strike N55°E and dip 20° to 25°NW, have been intruded by a diabase dike. The geologic map of the Lebanon Quadrangle (see map) shows a major diabase sheet just north of the dam. This sheet dips to the south at about 30°, but the upper surface has many irregularities. Exploration drilling for the dam found diabase to be present under the lower slopes of the valley. This is probably a continuation of the small mass shown in the tailings pond area on the geologic map. The mass is apparently a dike offshoot of the main diabase sheet. The dike approximately parallels the valley, and is probably responsible for the mapped fracture trace. There are no faults mapped in the area, but faults are known nearby, thus offsetting both the Hammer Creek and diabase formation.

Overburden

The sides of the valley were covered with colluvium derived from the Hammer Creek Formation, mostly sand and conglomerate boulders with some weathered shale. This was from 0 to 10 feet thick. In the center of the valley this colluvium covered the decomposed and weathered diabase.

Aquifer Characteristics

Diabase is a very impermeable rock. Ground water movement is entirely along joints and other fractures. The Hammer Creek beds are also relatively impermeable, ground water moves almost entirely along bedding planes and fractures. Tests made in the drill holes indicated that the weathered diabase was more permeable than the decomposed diabase. This means that there is a relatively permeable zone sandwiched between the decomposed diabase (near surface) and the fresh diabase; (depths of 17 to 30 feet).

Discussion

This dam was not constructed to impound water, but to hold tailings. It therefore, has a drain rather than a cutoff trench. It can only be commented that the decomposed diabase has a high clay content, and that the underlying permeable zone could keep that clay wet and therefore, susceptible to slippage.

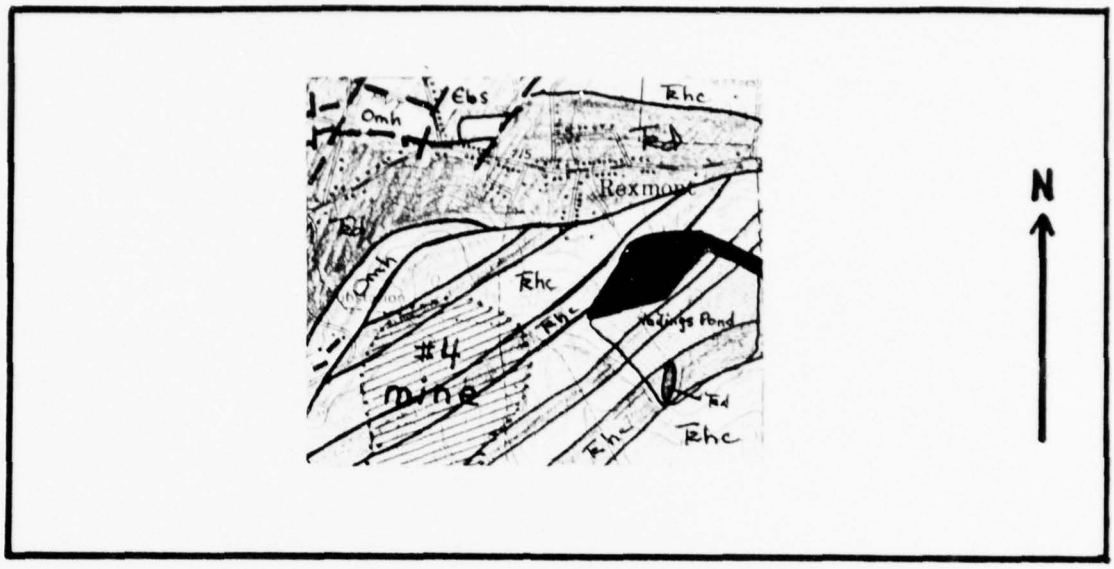
Sources of Information

1. Lapham, D.M. and Gray, C. (1972). "Geology and Origin of the Triassic Magnetite Deposit at Cornwall, Pa.". Pa. Geological Survey, Bulletin M56.

2. Air Photographs, dated 1969. Scale 1:20,000.

3. Core boring data in file.

GEOLOGIC MAP - Tailings Dam



(geology from Pa. Geol. Surv. Report M-56)

Trd	diabase
Trhc	Hammer Creek Fm.- sandstone and shale
Trhc	Hammer Creek Fm.- conglomerate lenses
Omh	Mill Hill Slate
Ebs	Buffalo Springs Fm.
— — —	fault
—·—·—	air photo fracture trace

SCALE 1:24000

1 0 1 MILE

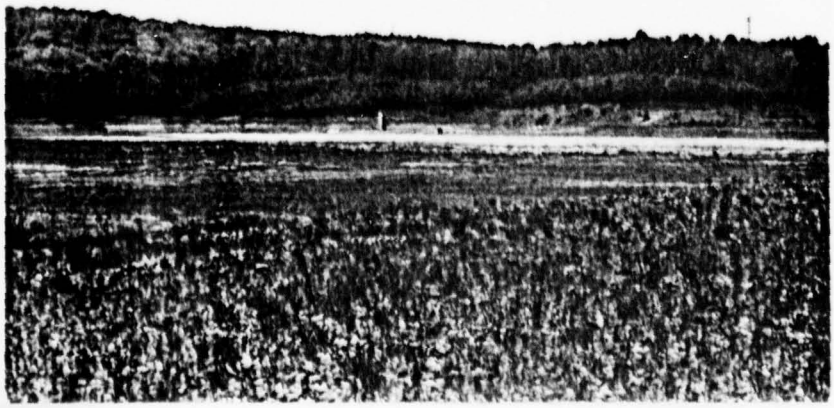
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

APPENDIX E

PHOTOGRAPHS

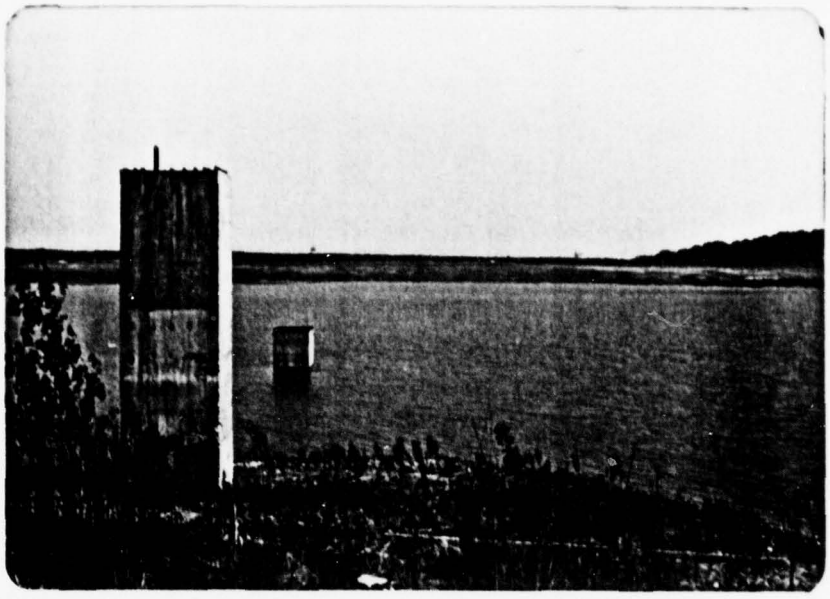
Top of Dam
Looking to
Left Abutment

Downstream Slope



View from top of
dam towards
decant towers

PA-597
Plate E-1



Reservoir with decant towers.
Dam in background

Detail of Decant Tower

PA-597
Plate E-II

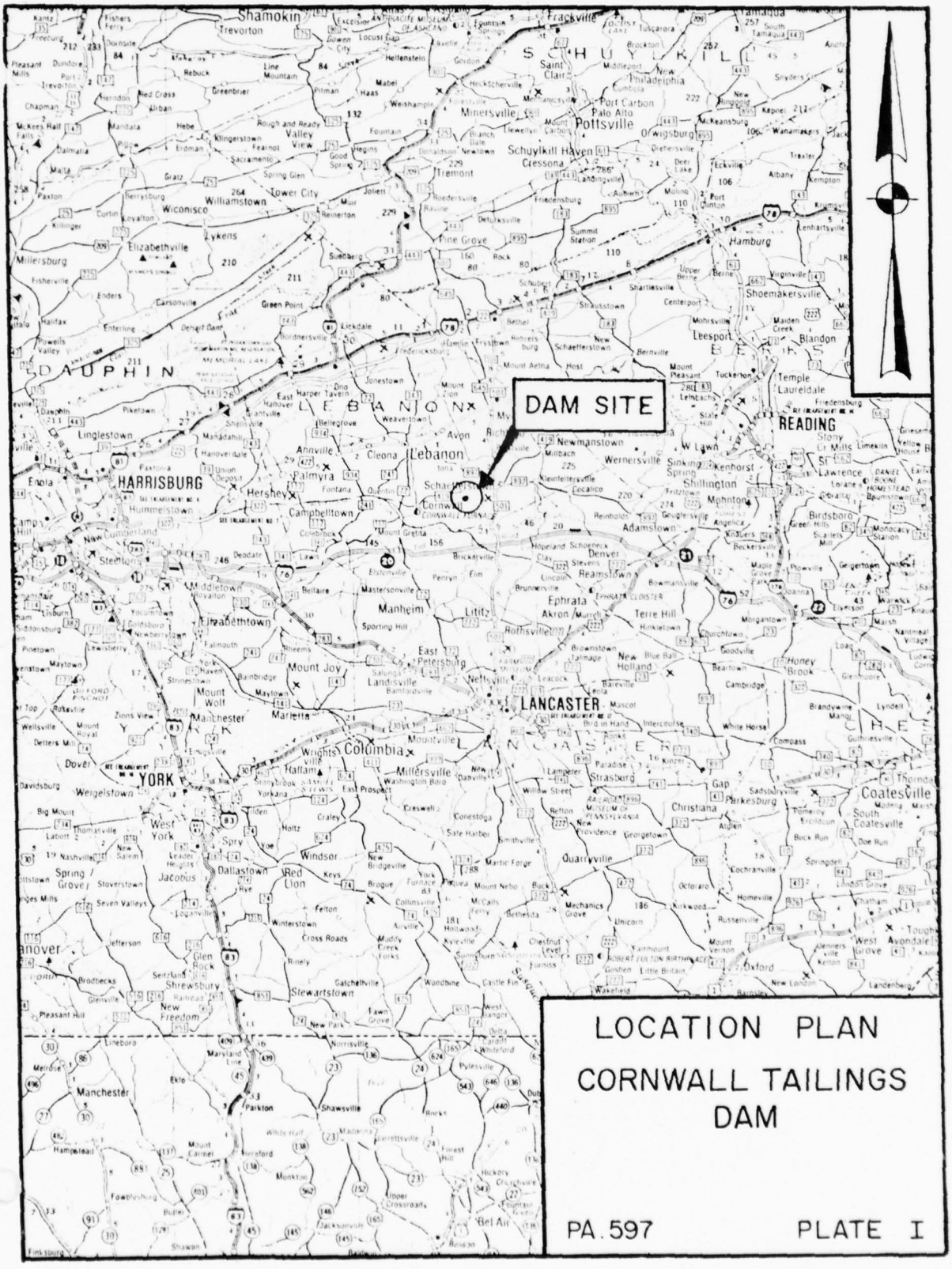
Reservoir - Dam in background

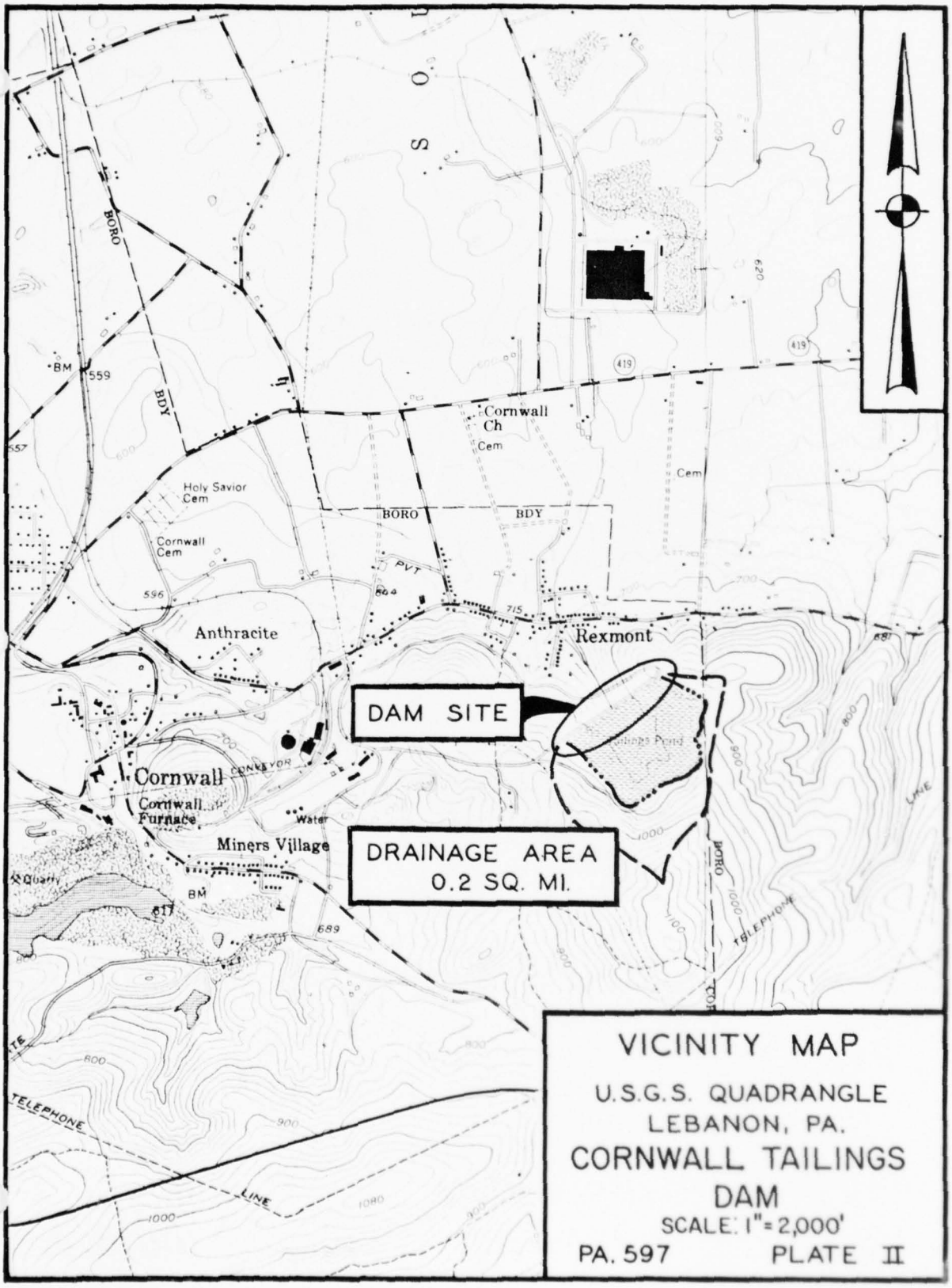
Looking downstream from top of dam

PA-597
Plate E-III

APPENDIX F

PLATES


DAM SITE
LOCATION PLAN
CORNWALL TAILINGS DAM
PA. 597
PLATE I



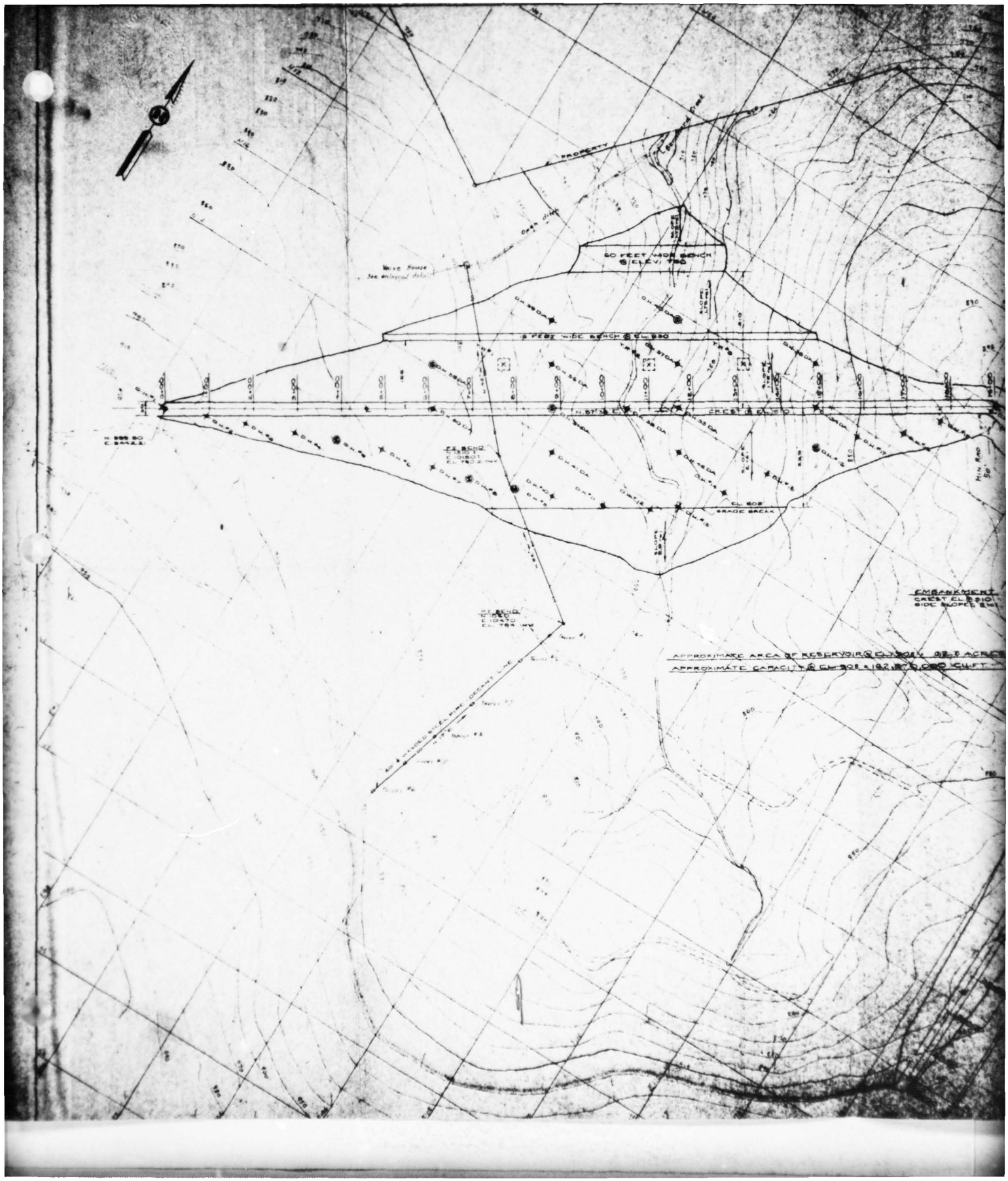
VICINITY MAP

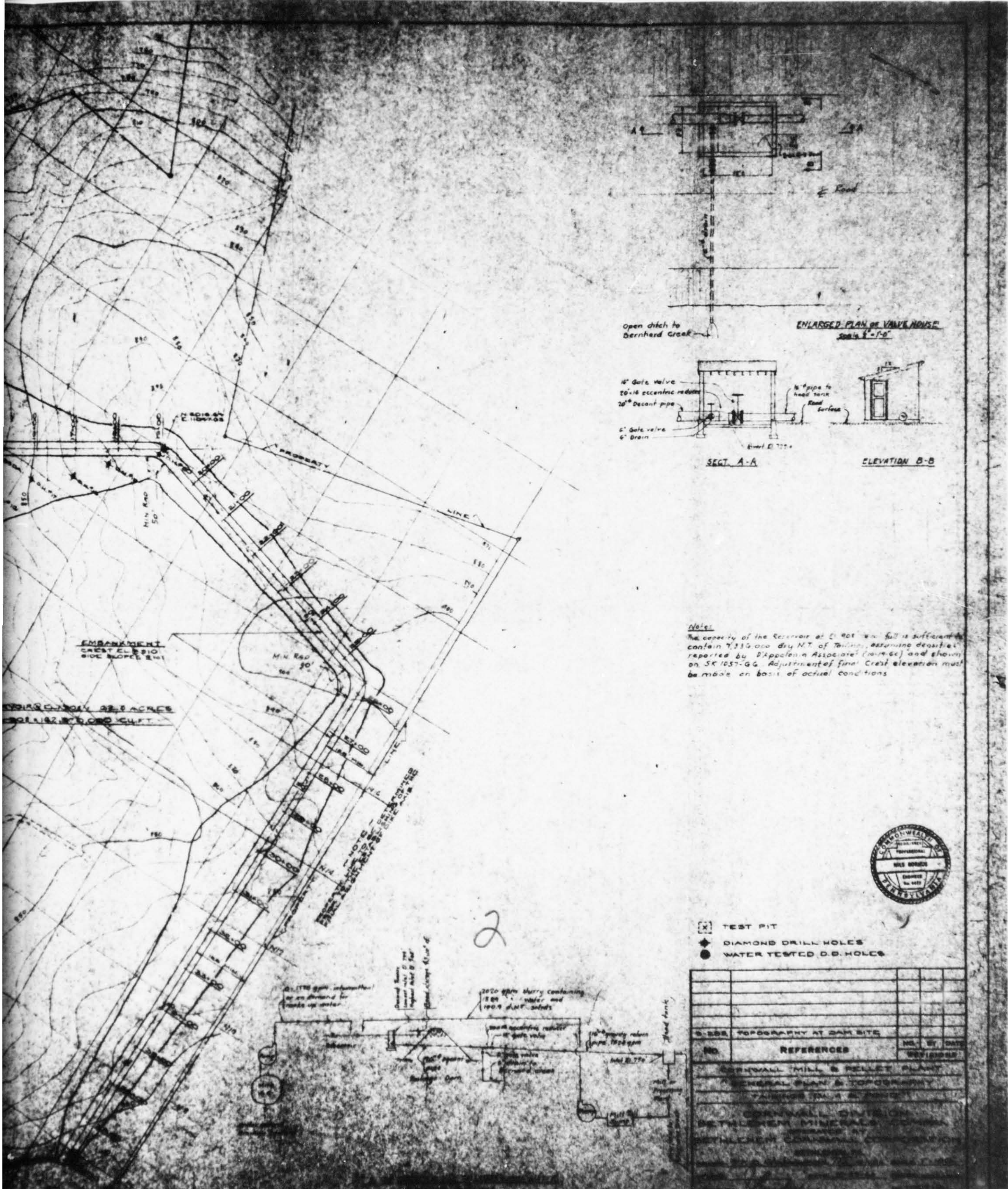
U.S.G.S. QUADRANGLE
LEBANON, PA.

CORNWALL TAILINGS DAM

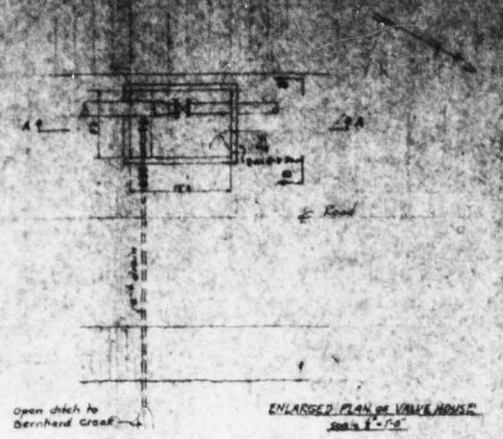
SCALE: 1" = 2,000'

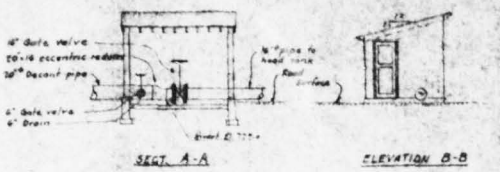
PA. 597 PLATE II


PROPERTY
50 FEET WIDE BENCH @ ELEV. 790
8 FEET WIDE BENCH @ EL. 830
EMBANKMENT
CREST EL 830'
EL 808
GRADE BREAK
APPROXIMATE AREA OF RESERVOIR @ EL 808 = 92.8 ACRES
APPROXIMATE CAPACITY @ EL 808 = 192,850,000 CU.FT.


ENLARGED PLAN of VALVE HOUSE
Open ditch to Bernhard Creek
16" Gate valve
20-16 eccentric reducer
20" Decant pipe
6" Gate valve
6" Drain
16" pipe to head tank
Road Surface
SECT. A-A
ELEVATION B-B
EMBANKMENT
MIN RAD 50'
PROPERTY
LINE
Notes
The capacity of the Reservoir at El 901 when full is sufficient to contain 7,336,000 dry N.T. of Tailings, assuming densities reported by D'Appolonia Associates (10-14-66) and shown on SK 1057-66. Adjustment of final Crest elevation must be made on basis of actual conditions
TEST PIT
DIAMOND DRILL HOLES
WATER TESTED D.D. HOLES
TOPOGRAPHY AT DAM SITE
NO.
REFERENCES
NO.
BY
DATE
REVISIONS
CORNWALL MILL & PELLET PLANT
GENERAL PLAN & TOPOGRAPHY
CORNWALL DIVISION
BETHLEHEM MINERALS COMPANY
BETHLEHEM CORNWALL CORPORATION
COMMONWEALTH OF PENNSYLVANIA
2

PA
PL





Note:
The capacity of the reservoir at El 901 when full is sufficient to contain 7,335,000 dry N.T. of Tailings, assuming densities reported by D'Appolonia Associates (1974-Ec) and shown on SK 1057-GG. Adjustment of final crest elevation must be made on basis of actual conditions.

2

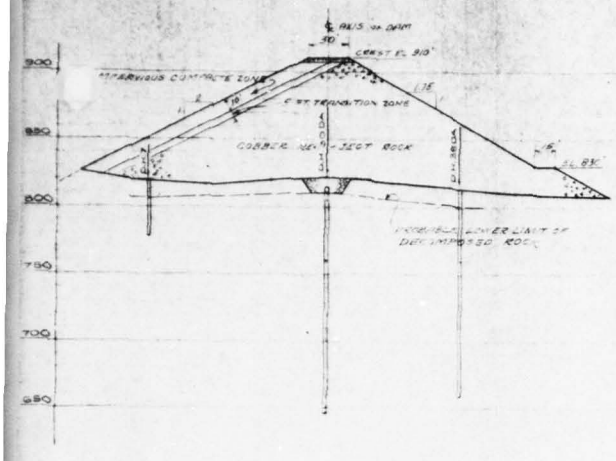
3

[X] TEST PIT
◆ DIAMOND DRILL HOLES
● WATER TESTED D.D. HOLES

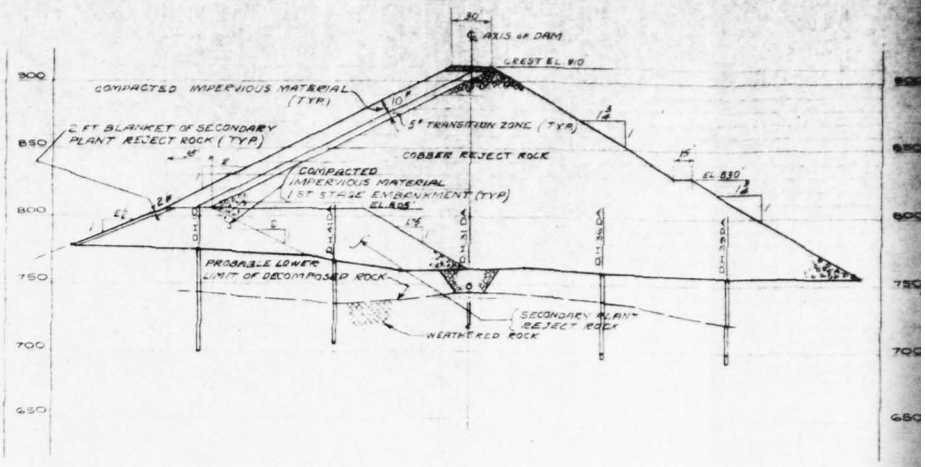
NO.	REFERENCED	NO.	BY	DATE
S-888	TOPOGRAPHY AT DAM SITE			

CORNWALL MILL & PELLET PLANT
GENERAL PLAN & TOPOGRAPHY
CORNWALL DIVISION
BETHLEHEM MINES COMPANY

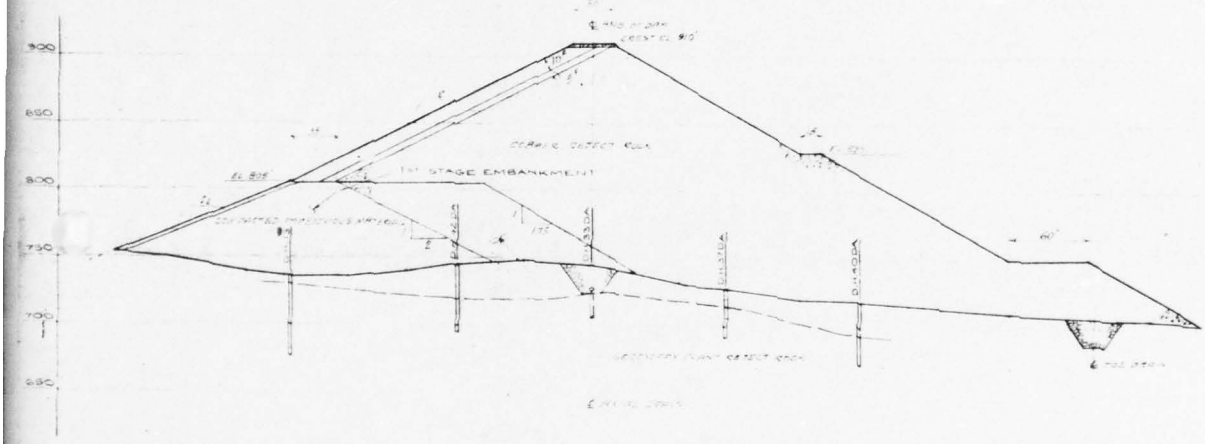
PA. 597
PLATE III



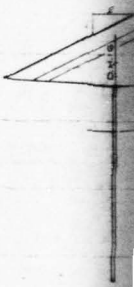
SECTION 1) 1

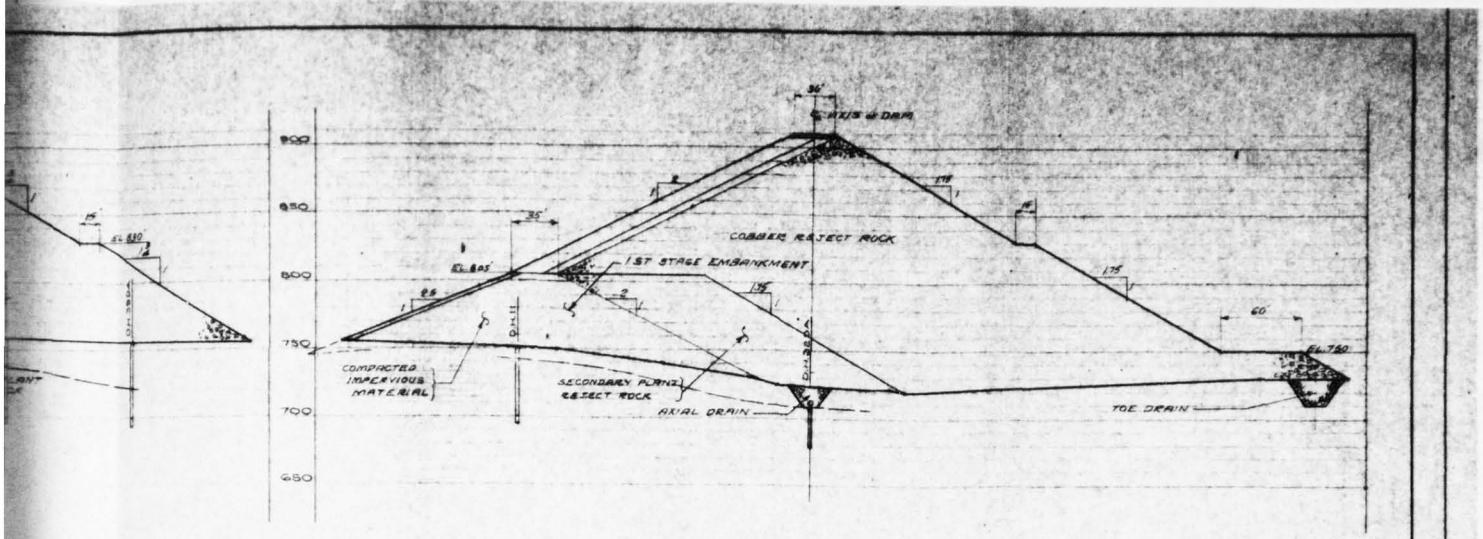


SECTION 2) 2

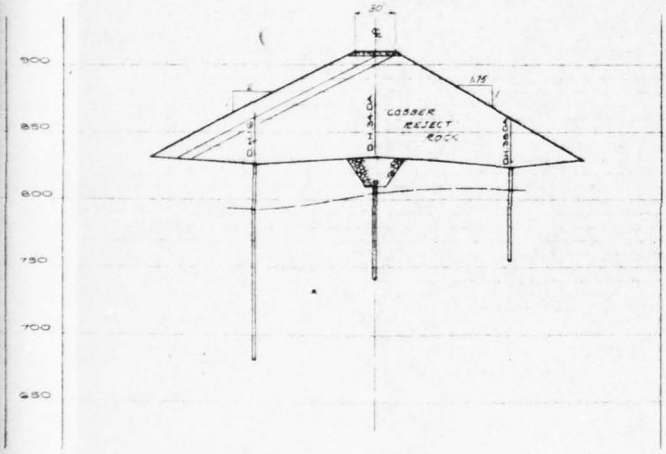


SECTION 4) 4

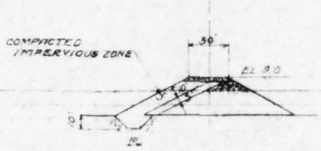




SECTION ③-③
℄ STA. 10+80



SECTION ⑤-⑤
℄ STA 14+85



TYPICAL CROSS-SECTION OF WING

2

1057-91	GENERAL PLAN TAILINGS DAM			
REFERENCE DWG. NO.	REFERENCE TITLE	NO.	BY	DATE
		REVISIONS		

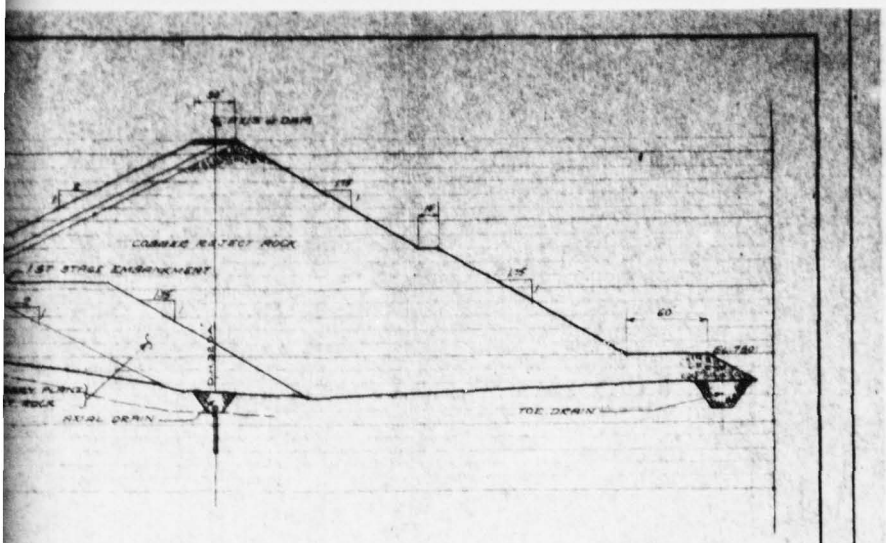
CORNWALL MILL & PELLET PLANT

TYPICAL CROSS-SECTIONS OF TAILINGS DAM

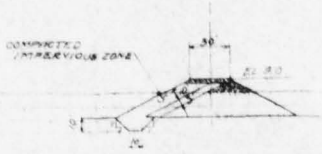
CORNWALL DIVISION
BETHLEHEM MINERALS COMPANY
OPERATED BY
BETHLEHEM CORNWALL CORPORATION
BETHLEHEM, PA.

DRAWN: E.R.D.S. 12-1-60 CHECKED: [illegible] SCALE: 1"=50'
TRACED: [illegible] DATE: 12-1-60 ORDER, DATE, NO.
APPROVED: [illegible]

PA
PL



SECTION ③-③
@ STA. 10+00



TYPICAL CROSS-SECTION OF WING

2

1087-01	GENERAL PLAN TAILINGS DAM			
REFERENCE DWG. NO.	REFERENCE TITLE	NO.	BY	DATE
		REVISIONS		

CORNWALL MILL & PELLET PLANT

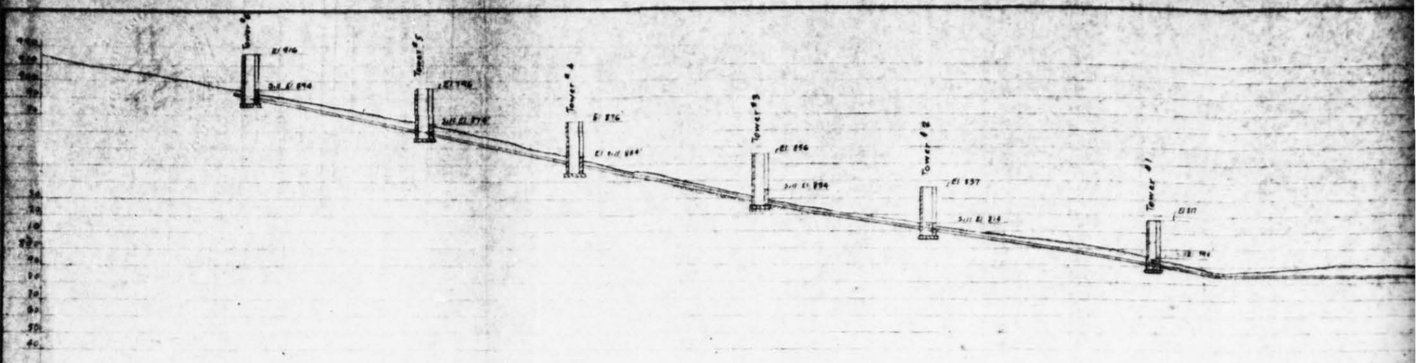
TYPICAL CROSS-SECTIONS OF TAILINGS DAM

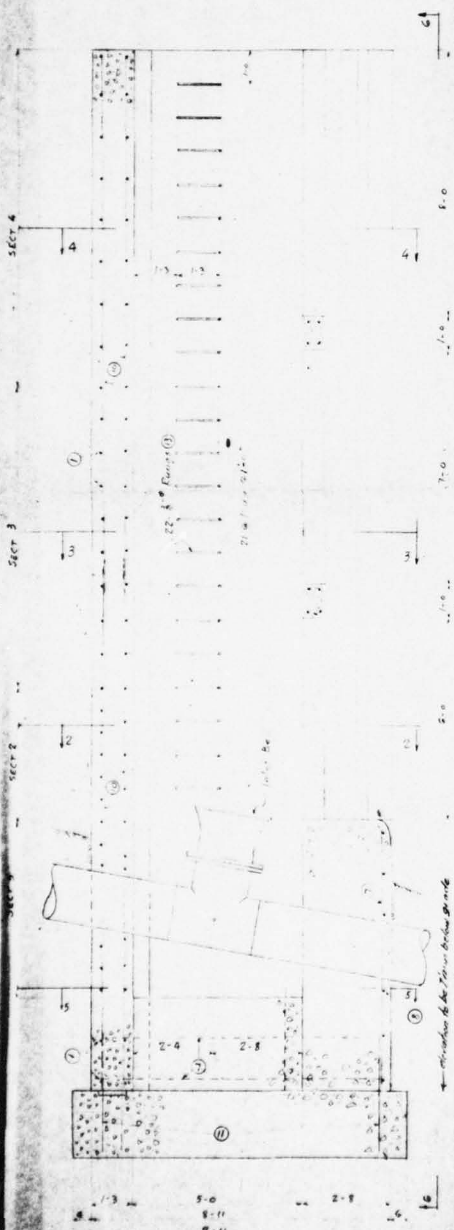
CORNWALL DIVISION
BETHLEHEM MINERALS COMPANY
OPERATED BY
BETHLEHEM CORNWALL CORPORATION
BETHLEHEM, PA.

DRAWN: C.R.D. & R.C. CHECKED: 12/22/60 SCALE: 1"=30'
TRACED: DATE: 12-1-60 CROSS SECTS.: 1"=30'
APPROVED: No. 1087-B-5

3

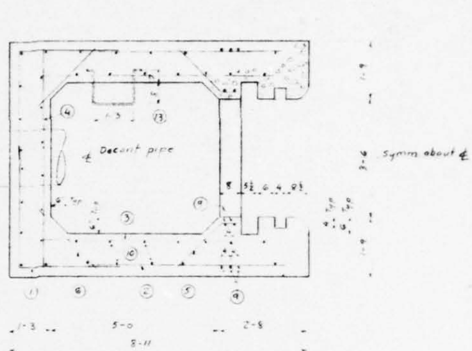
PA.-597
PLATE IV





... foundation shall be
...red to firm soil
...pable of supporting
... per sq ft toe pressure

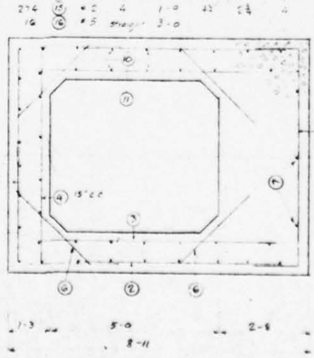
SECT 1-1
Scale 1/2"=1'-0"



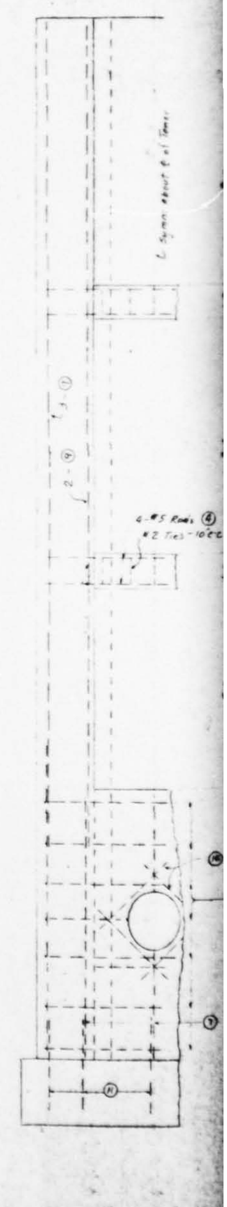
SECTIONS 2-2, 3-3 & 4-4

LIST of REINFORCING BARS – ONE TOWER

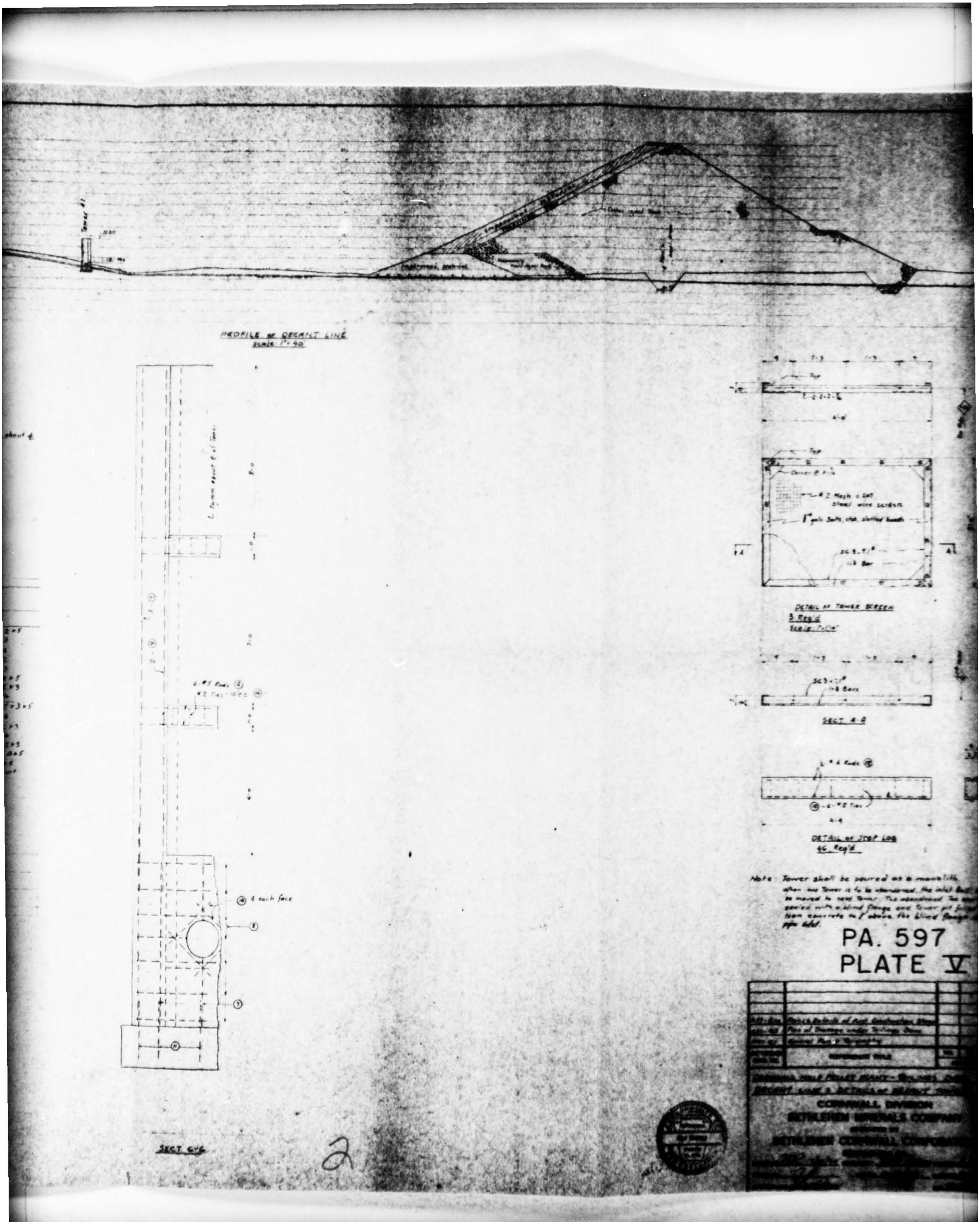
No	Mark	Size	Type	Length	Dimensions A	B	C	
70	1	#5	1	6-9	3-9	3-0		Spaced 8" cc Sect 2 & 5; " 12" cc " 3; " 15" cc " 4
64	2	#5	Straight	6-0				" 8" cc " 2; " 12" cc " 3; " 15" cc " 4 & 5
56	3	#5	Straight	7-0				" 12" cc " 2 & 3; " 15" cc " 4
28	4	#5	Straight	6-6				" 12" cc " 2 & 3 & 5; " 15" cc " 4
44	5	#5	2	2-6	2-0	0-6		" 12" cc " 2 & 3; " 15" cc " 4
56	6	#5	Straight	2-6				" 12" cc " 2 & 3; " 15" cc 4 & 5
7	7	#5	Straight	8-6				Shown in Sect's 1 & 5. Cut in the field to suit
8	8	#5	3	9-6	1-6	6-6	1-6	Sect 5-5
10	9	#6	Straight	25-0				Sect's 2-3 & 4
84	10	#4	Straight	16-3				Sect 5
42	11	#4	1	3-6	3-0	0-6		Dowels Sect's 1 & 5
84	12	#	Straight	4-3				Stop Logs
22	13	#6	5	4-3	3	1-3	1-3	Ladder
10	14	#2	4	3-4	10	6	4	Tie
274	15	#2	4	1-0	4½	5¾	4	Tie
16	16	#5	Straight	3-0				Sect 6-6



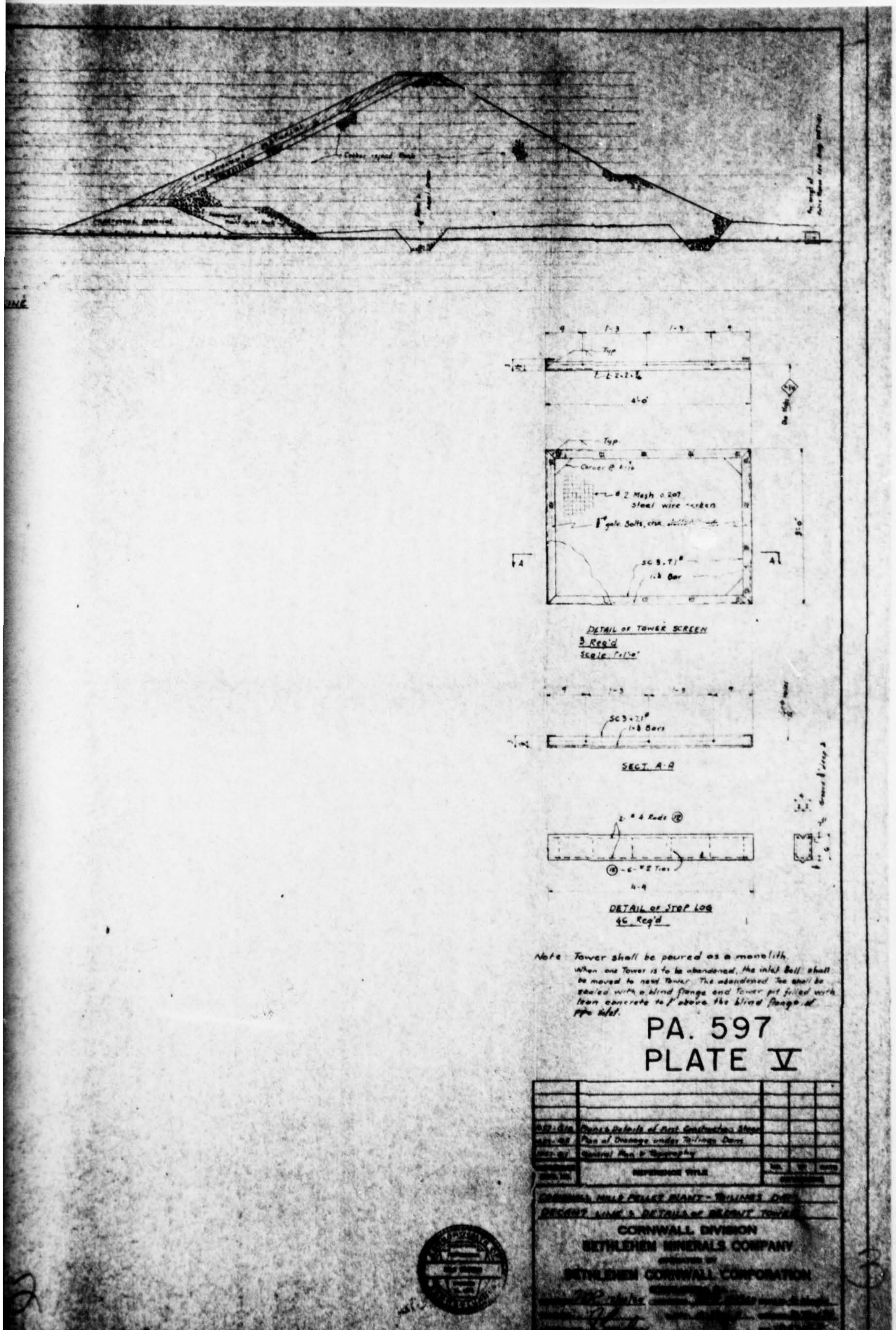
SECT 5-5



SECT 6-6



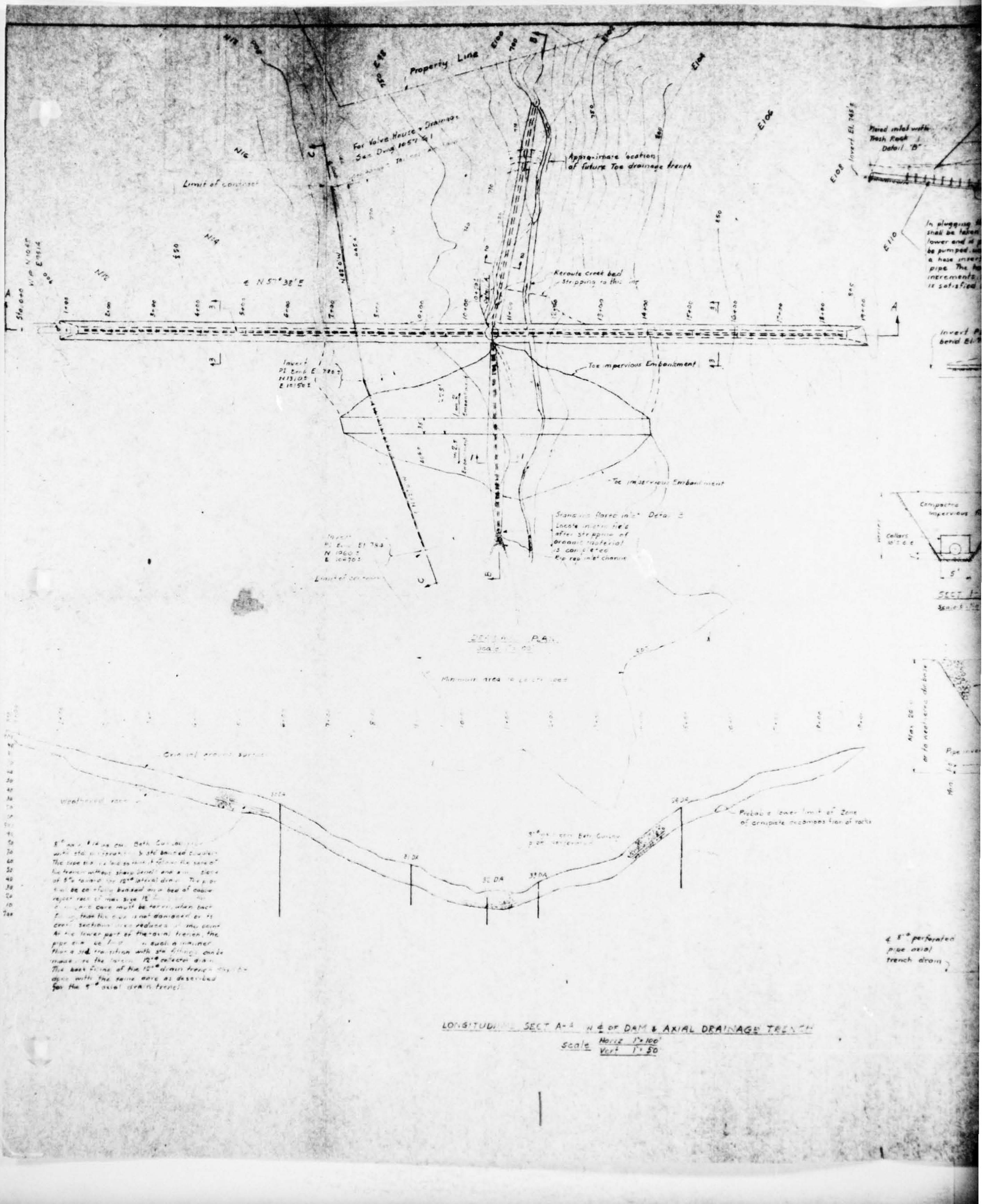
PA. 597
PLATE V

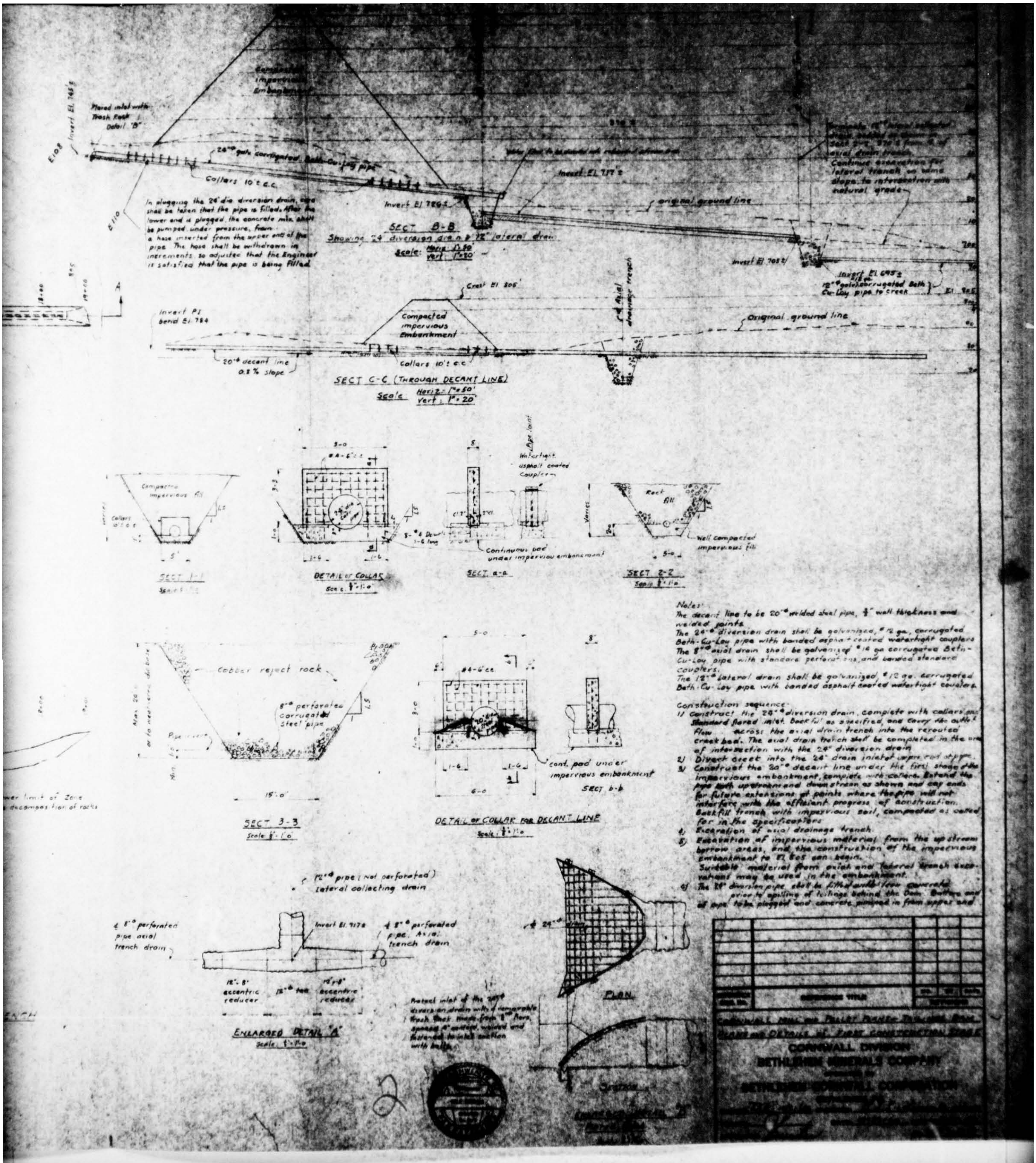


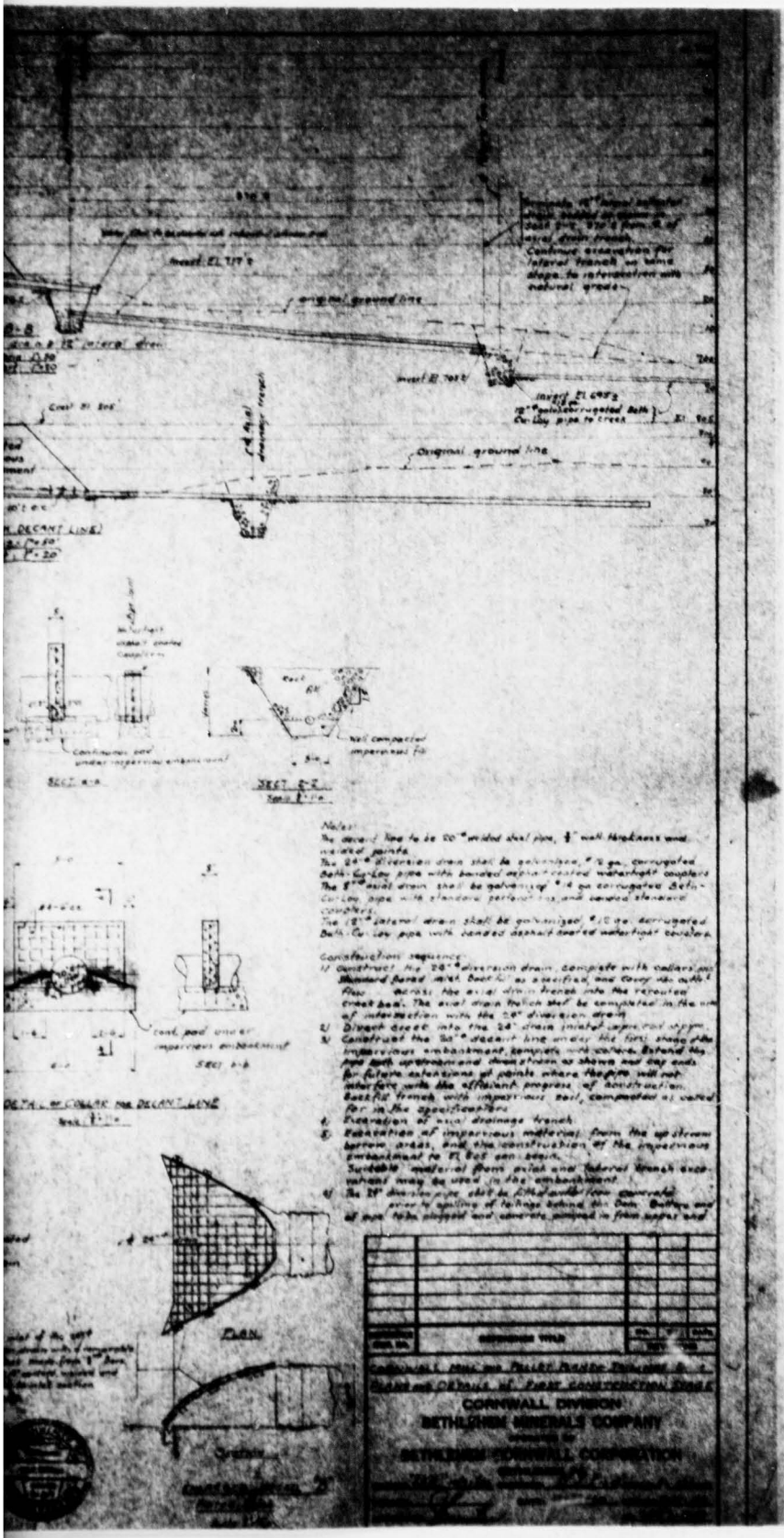
PA. 597
PLATE V

Detail of Decant Tower

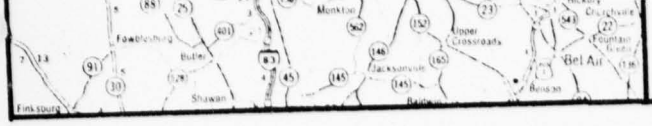
PA-597
Plate E-II




Flared inlet with Trash Rack Detail "B"
Invert El. 745±
24"Ø galv. corrugated Beth-Cu-Loy pipe
Collars 10' c.c.
Invert El. 737±
Invert El. 726±
original ground line
SECT. B-B
Showing 24" diversion drain & 12" lateral drain
Scale: Horiz. 1"=50' Vert. 1"=20'
In plugging the 24" dia. diversion drain, care shall be taken that the pipe is filled. After the lower end is plugged, the concrete mix shall be pumped under pressure, from a hose inserted from the upper end of the pipe. The hose shall be withdrawn in increments so adjusted that the Engineer is satisfied that the pipe is being filled.
Invert El. 705±
Invert El. 695±
12"Ø galv. corrugated Beth-Cu-Loy pipe to creek
Crest El. 805'
Compacted impervious Embankment
Invert PI bend El. 784
Original ground line
Collars 10' c.c.
20"Ø decant line 0.5% slope
SECT. C-C (THROUGH DECANT LINE)
Scale Horiz. 1"=50' Vert. 1"=20'
Compacted impervious fill
Collars 10' c.c.
5'
SECT. 1-1
DETAIL OF COLLAR
Scale 1"=1'-0"
Watertight asphalt coated Coupler
Continuous pad under impervious embankment
SECT. a-a
Rock fill
Well compacted impervious fill
SECT. 2-2
Scale 1"=1'-0"
Cobber reject rock
8"Ø perforated corrugated steel pipe
15'-0"
SECT. 3-3
Scale 1"=1'-0"
cont. pad under impervious embankment
SECT. b-b
DETAIL OF COLLAR FOR DECANT LINE
Scale 1"=1'-0"
Notes:
The decant line to be 20"Ø welded steel pipe, 3/8" wall thickness and welded joints.
The 24"Ø diversion drain shall be galvanized, #12 ga., corrugated Beth-Cu-Loy pipe with banded asphalt coated watertight couplers.
The 8"Ø axial drain shall be galvanized #14 ga corrugated Beth-Cu-Loy pipe with standard perforations and banded standard couplers.
The 12"Ø lateral drain shall be galvanized, #12 ga. corrugated Beth-Cu-Loy pipe with banded asphalt coated watertight couplers.
Construction sequence:
1) Construct the 24"Ø diversion drain, complete with collars and Standard flared inlet. Backfill as specified, and carry the outlet flow across the axial drain trench into the rerouted creek bed. The axial drain trench shall be completed in the area of intersection with the 24" diversion drain.
2) Divert creek into the 24" drain inlet at upper end of pipe.
3) Construct the 20"Ø decant line under the first stage of the impervious embankment, complete with collars. Extend the pipe both upstream and downstream as shown and cap ends for future extensions at points where the pipe will not interfere with the efficient progress of construction. Backfill trench with impervious soil, compacted as called for in the specifications.
4) Excavation of axial drainage trench.
5) Excavation of impervious material from the upstream borrow areas, and the construction of the impervious embankment to El. 805 can begin. Suitable material from axial and lateral trench excavations may be used in the embankment.
6) The 24" diversion pipe shall be filled with lean concrete prior to spilling of tailings behind the Dam. Bottom end of pipe to be plugged and concrete pumped in from upper end.
12"Ø pipe (Not perforated) Lateral collecting drain
℄ 8"Ø perforated pipe axial trench drain
Invert El. 717±
℄ 8"Ø perforated pipe. Axial trench drain
12"-8" eccentric reducer
12"Ø tee
12"-8" eccentric reducer
ENLARGED DETAIL "A"
Scale 1"=1'-0"
Protect inlet of the 24"Ø diversion drain with a removable trash rack made from 3/4" bars spaced 4" centers, welded and fastened to inlet section with bolts.
PLAN
CORNWALL DIVISION
BETHLEHEM MINERALS COMPANY
BETHLEHEM CORNWALL CORPORATION



PA. 597
PLATE VI

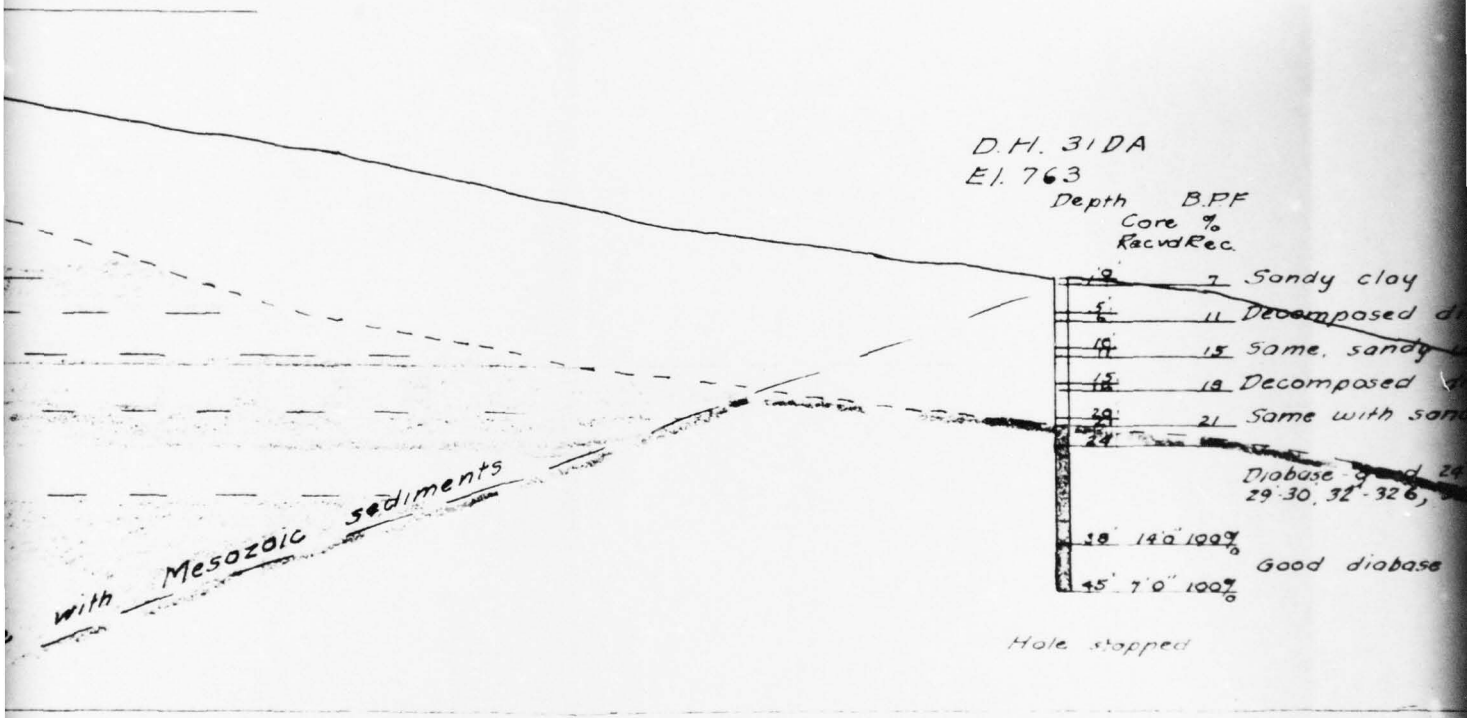


PA. 597 PLATE I

D.H. 30 DA
El. 828

Depth	Core Recvd	% Rec.	B.P.F	
0'			2	Brown sandy clay & gravel
4'			14	Brown clay & cg frags
9'6"			200	Silty sandstone fragments
				Good cong Bottom of run is shale
				Badly broken mottled red shale
EL. 800				
				No core 25'-28' Balance badly broken sandstone
32' 6"	3"	66%		Badly broken conglomerate
39' 8"	9"	96%		Some
46' 7"	0"	100%		Cong 1st 1' and last 8" badly broken. Bal solid
50' 5"	0"	60%		Dark gray broken sandstone
52' 1"	11"	96%		Top 2'9" dark very f.g. Ss Bal is broken gray Ss
56' 6"	3"	100%		Hard red-gray Ss Last 1' broken
60' 4"	6"	100%		Ss. to 62'6", then cong. all broken
66' 6"	0"	100%		First 4' mottled red shale- then sandstone
71' 5"	0"	100%		Sandstone - broken 76'-77'
77' 6"	0"	100%		
EL 750'				
82' 5"	0"	100%		Hard mottled red shale
85' 1"	7"	53%		Mottled red shale
88' 3"	0"	100%		Cong - little shale Upper 3' badly broken
91' 2"	0"	100%		Ss & shale last 5' badly broken
				No core
97' 5"	11"	92%		Gray sandstone Broken 91'-93' & 95'6"-96'
100' 3"	0"	100%		Conglomerate
104' 4"	0"	100%		Cong little indication diabase mineralization
108' 4"	0"			Cong-less diabase staining Ss 104'-104'9"
114' 3"	6"	100%		Conglomerate Good core
				Conglomerate weathered zones 117'-114', 117'-118' and 124'-124'6"
EL. 700'				
				Approx contact of diabase with M
126' 30"		100%		
				Gray sandstone - weathered & broken
169' 27"	6"	100%		No Core
174' 2'	6"	83%		
177'				No core
179' 180' 9"	3"	38%		Weathered & decomposed diabase
				Good core - weathered diabase

DAM
SCALE: 1" = 2,000'
PA. 597 PLATE II



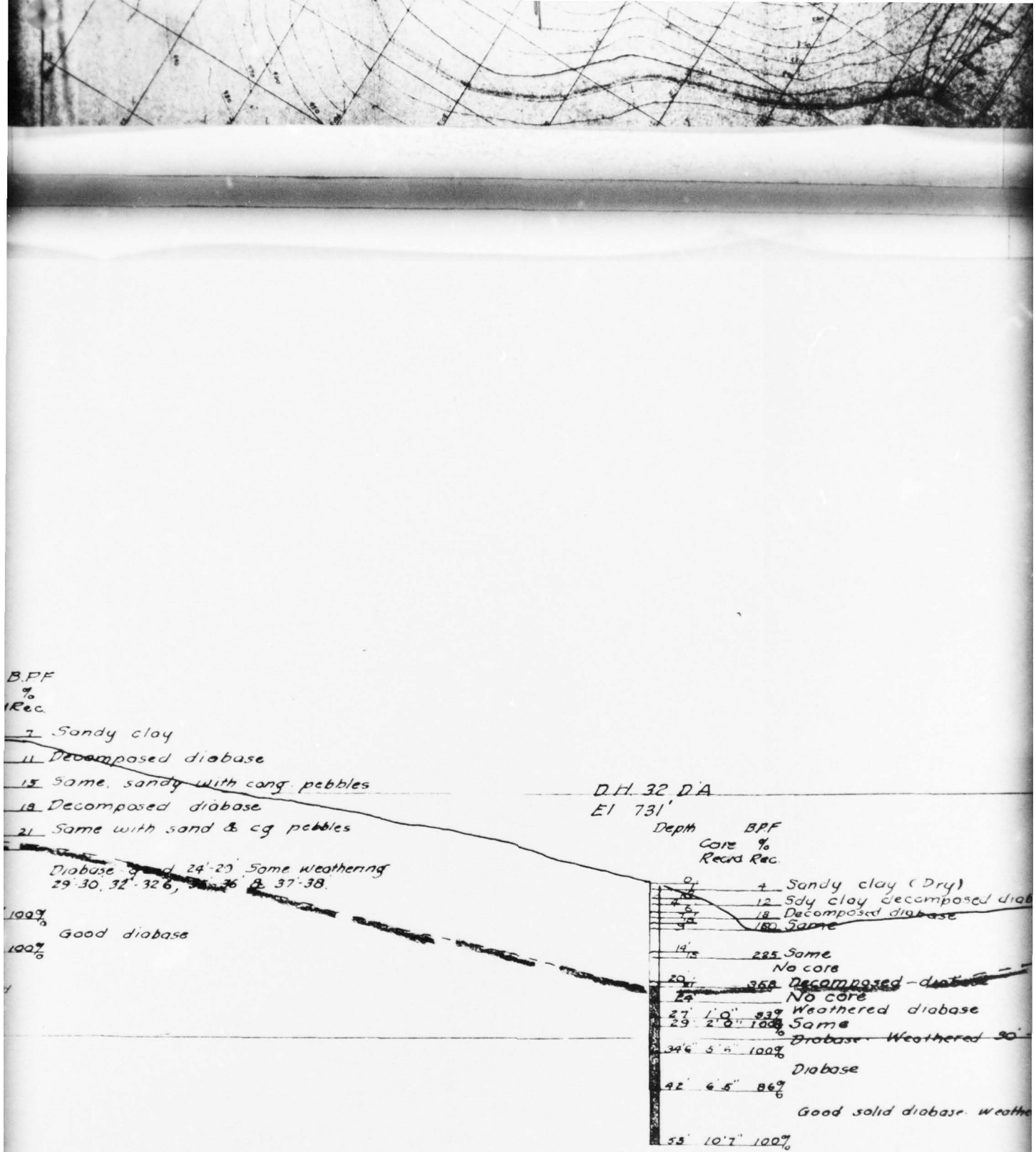
Sandstone

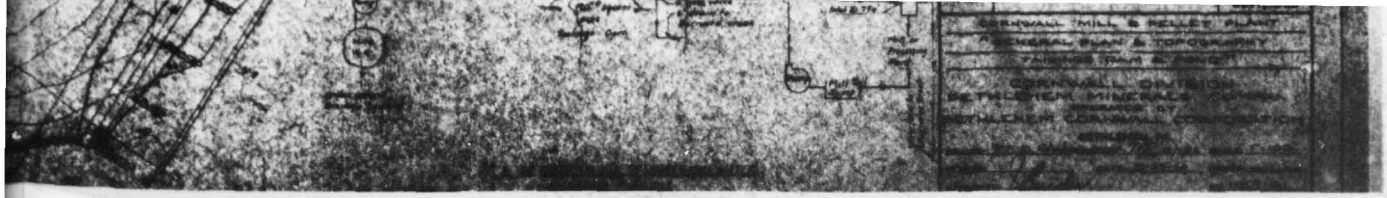
Conglomerate

Shale

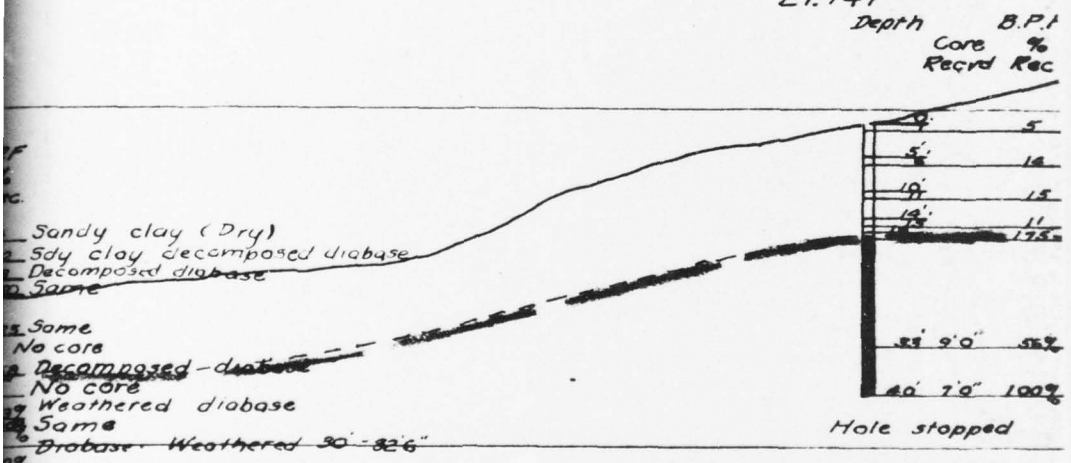
Diabase

2


B.P.F
% Rec.
7 Sandy clay
11 Decomposed diabase
15 Same, sandy with cong. pebbles
18 Decomposed diabase
21 Same with sand & cg pebbles
Diabase ... 24'-29' Some weathering
29'-30', 32'-32'6", ... 36' & 37'-38'.
100%
Good diabase
100%
D.H. 32 D'A
El 731'
Depth
Core Recrd
B.P.F % Rec.
4 Sandy clay (Dry)
12 Sdy clay decomposed diab
18 Decomposed diabase
180 Same
225 Same
No core
Decomposed - diabase
24
No core
27' 1'0" 83%
Weathered diabase
29' 2'0" 100%
Same
Diabase. Weathered 30'-
34'6" 5'6" 100%
Diabase
42' 6'5" 86%
Good solid diabase. weathe
53' 10'7" 100%



D.H. 33 D'A
El. 747

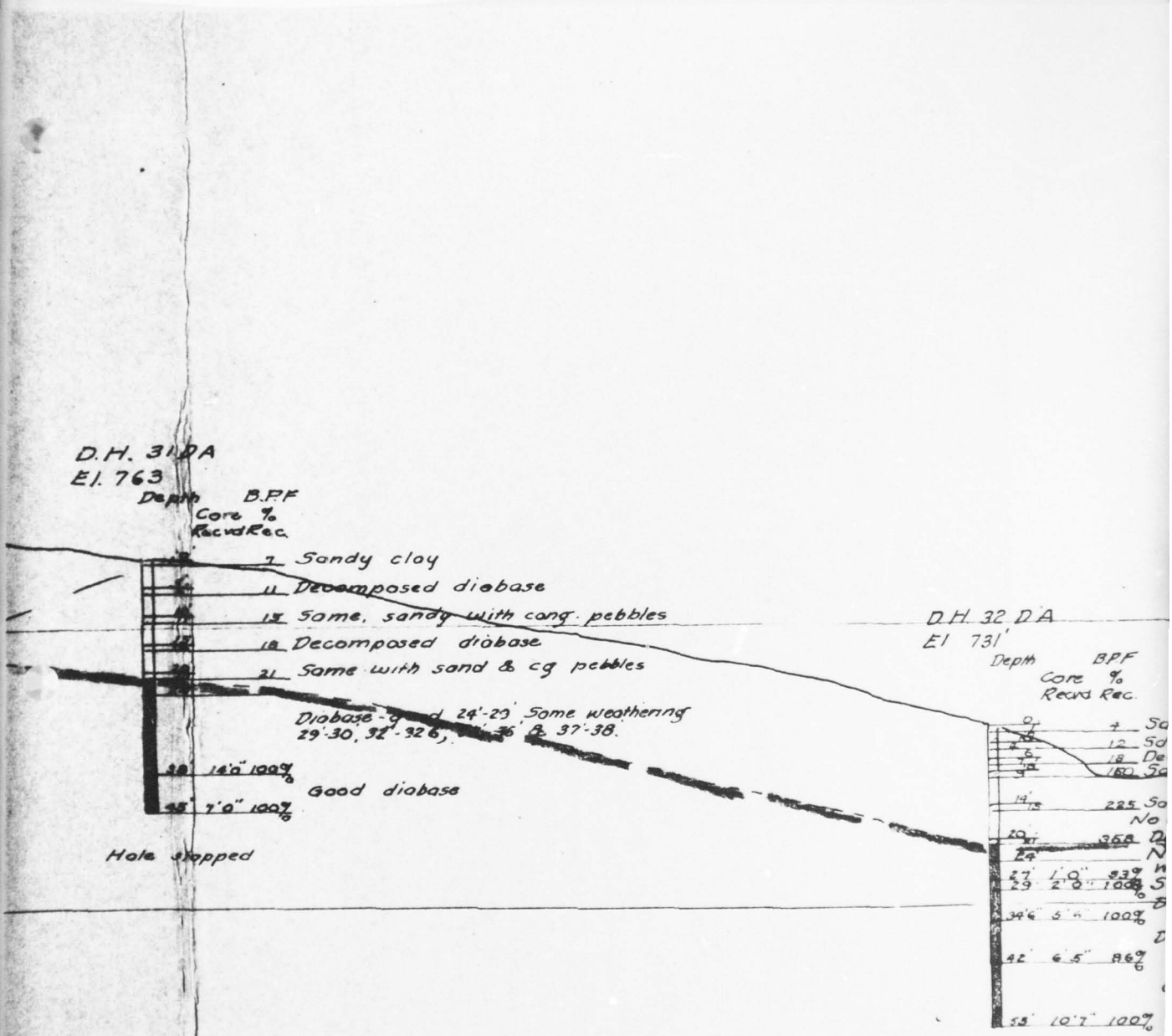


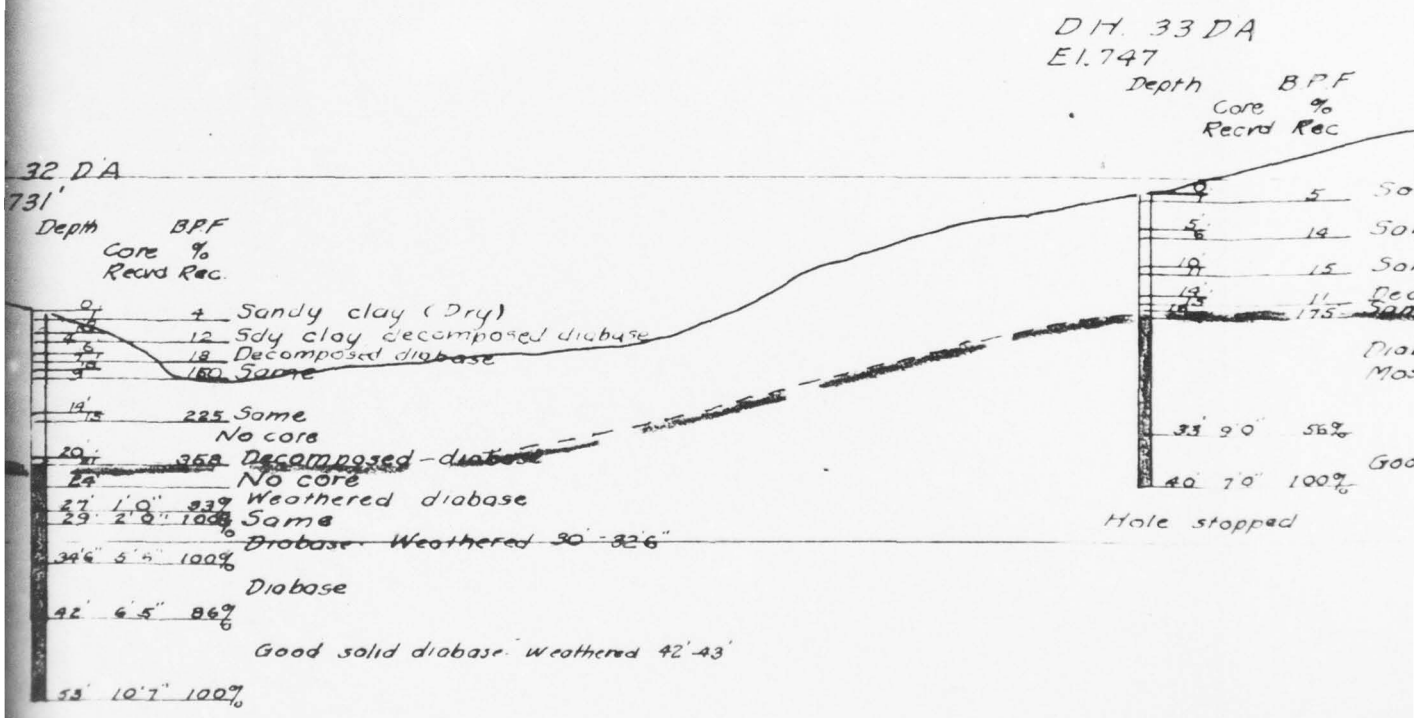
PA. 597
PLATE VII

Note:

Blows per foot spoon samples and % core recovered are shown in the same column. Drill hole elevations are from Map 224 pl. 4 and may vary a few feet from levels run to holes.

PA. 597
PLATE III

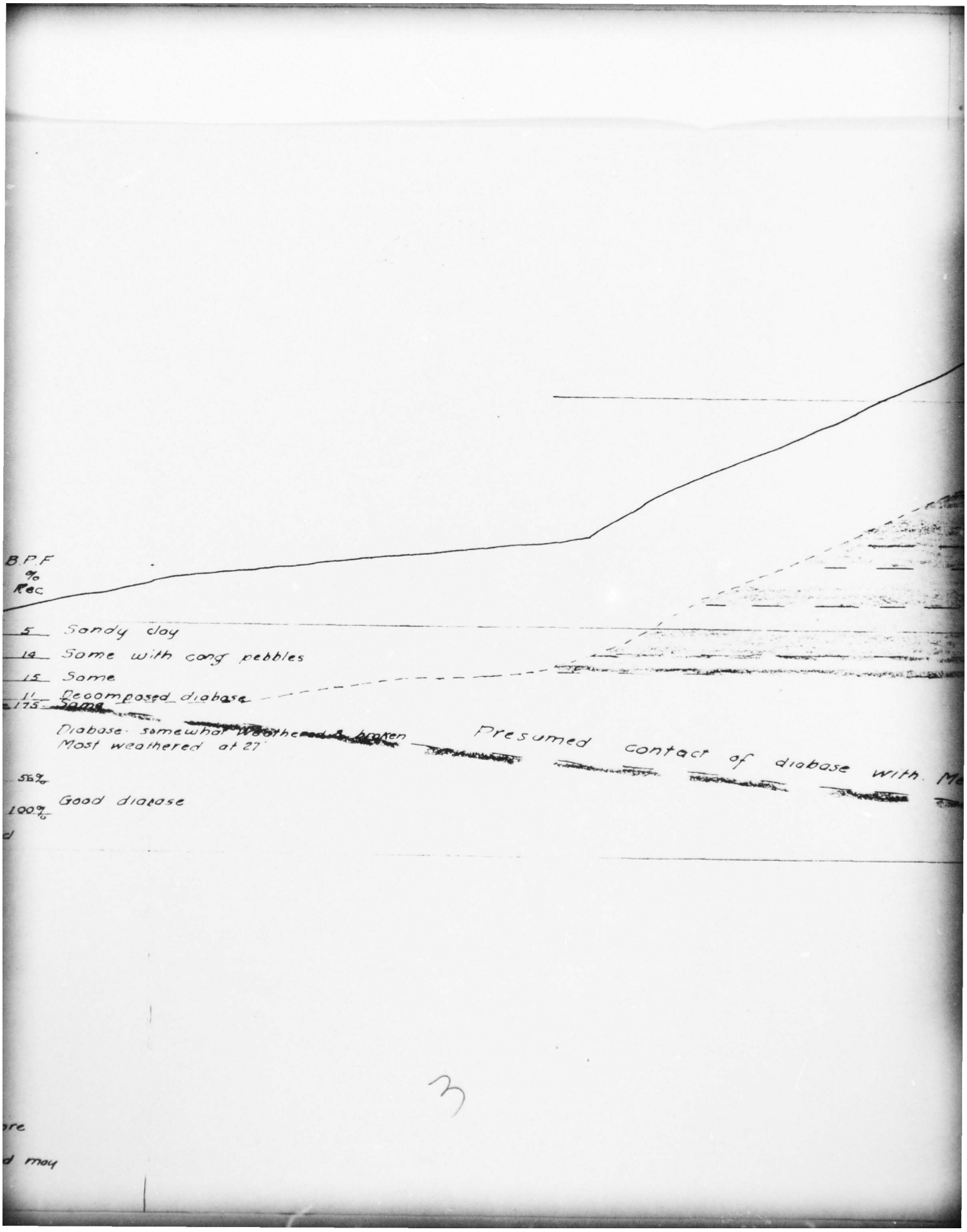


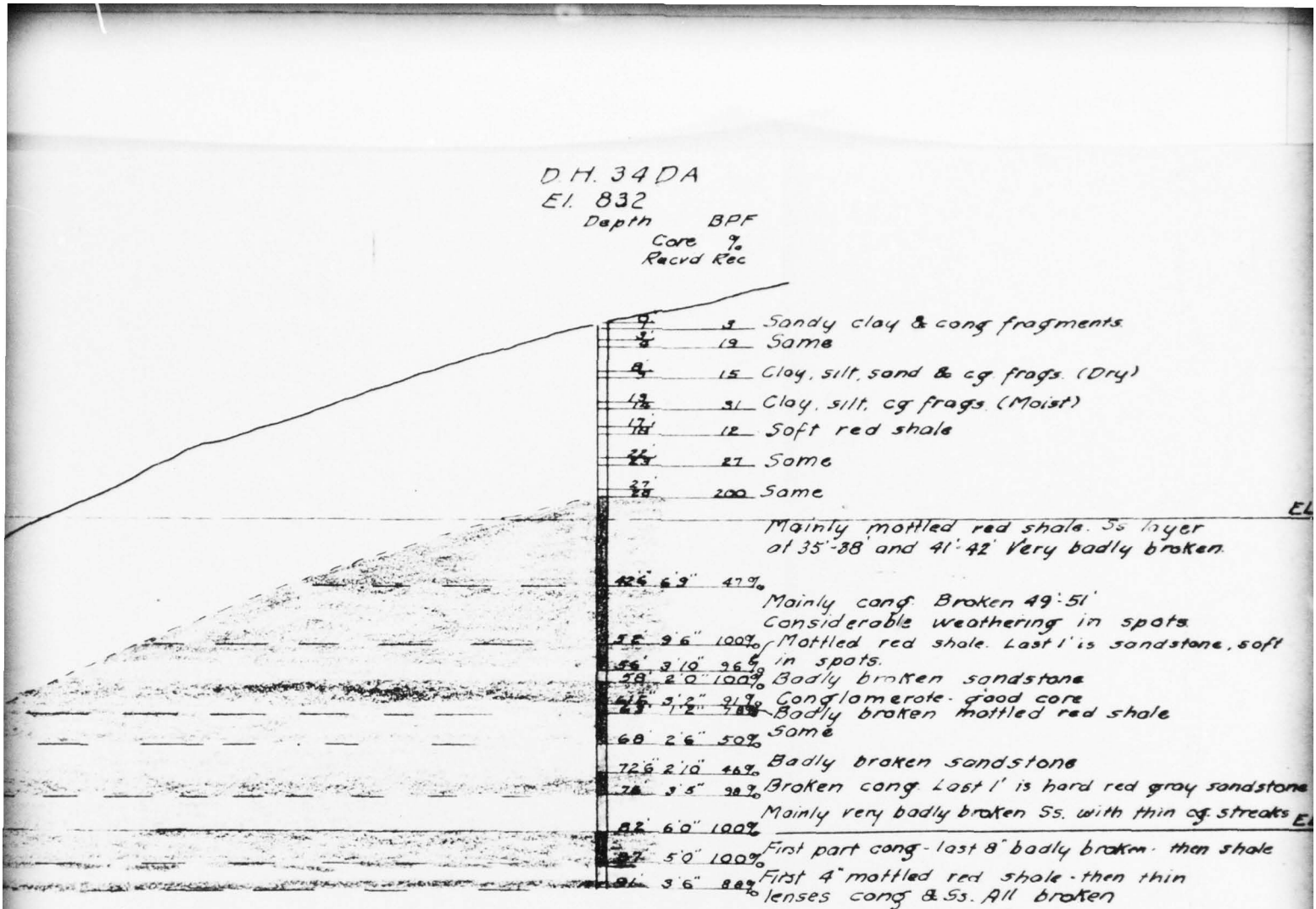


2

Note:

Blows per foot spoon samples and % core recovered are shown in the same column. Drill hole elevations are from Map 224 pl. 4 and may vary a few feet from levels run to holes.


B.P.F
%
Rec
5 Sandy clay
14 Some with cong pebbles
15 Some
11 Decomposed diabase
175 Some
Diabase somewhat weathered & broken
Most weathered at 27'
Presumed contact of diabase with Me
56%
100%
Good diabase



4

SECTION
THROUGH
DRILL HOLES 30DA, 31DA, 32DA, 33DA & 3
PROPOSED TAILINGS DAM
CORNWALL
SCALE 1" - 20'

0 10' 20' 40'

)A

BPF
ve %
cvd Rec

3 Sandy clay & cong fragments
19 Same
15 Clay, silt, sand & cg frags. (Dry)
31 Clay, silt, cg frags. (Moist)
12 Soft red shale
27 Same
200 Same

EL. 800'

Mainly mottled red shale. Ss layer at 35'-38' and 41'-42' Very badly broken.

9" 47%
Mainly cong. Broken 49'-51'
Considerable weathering in spots.
6" 100% Mottled red shale. Last 1' is sandstone, soft
10" 96% in spots.
0" 100% Badly broken sandstone
6" 9?% Conglomerate - good core
Badly broken mottled red shale
6" 50% Same
10" 48% Badly broken sandstone
6" 38% Broken cong. Last 1' is hard red gray sandstone
Mainly very badly broken Ss. with thin cg. streaks EL 750'
0" 100%
0" 100% First part cong - last 8" badly broken - then shale
6" 88% First 4" mottled red shale - then thin lenses cong & Ss. All broken

opped

EL. 700'

5

SECTION
THROUGH
HOLES 30DA, 31DA, 32DA, 33DA & 34DA
PROPOSED TAILINGS DAM
CORNWALL
SCALE 1" - 20'
0 10' 20' 40'

PA. 597
PLATE VIII